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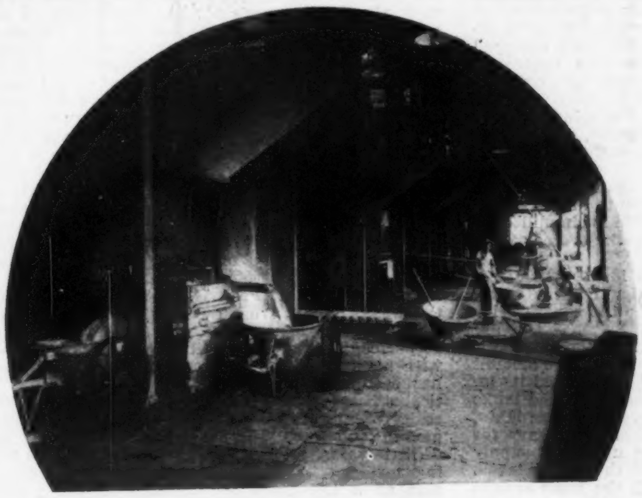
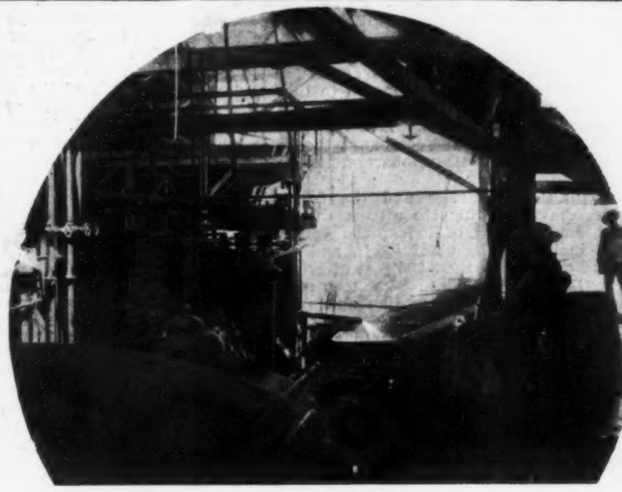
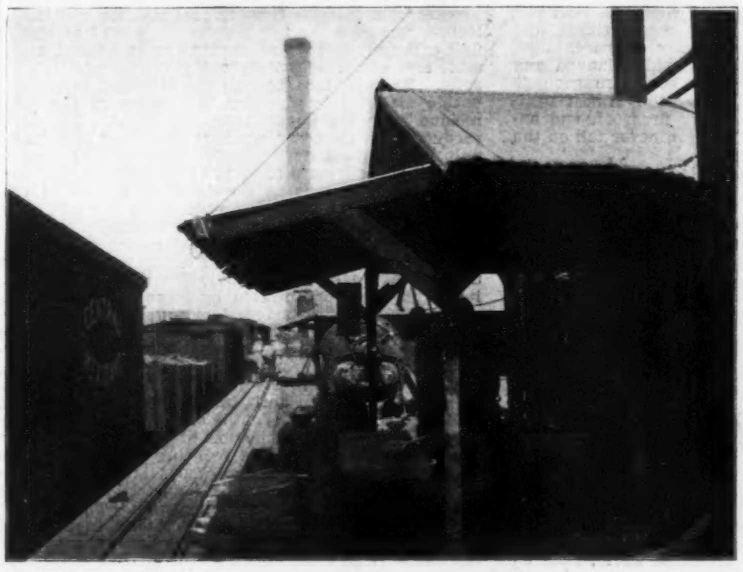


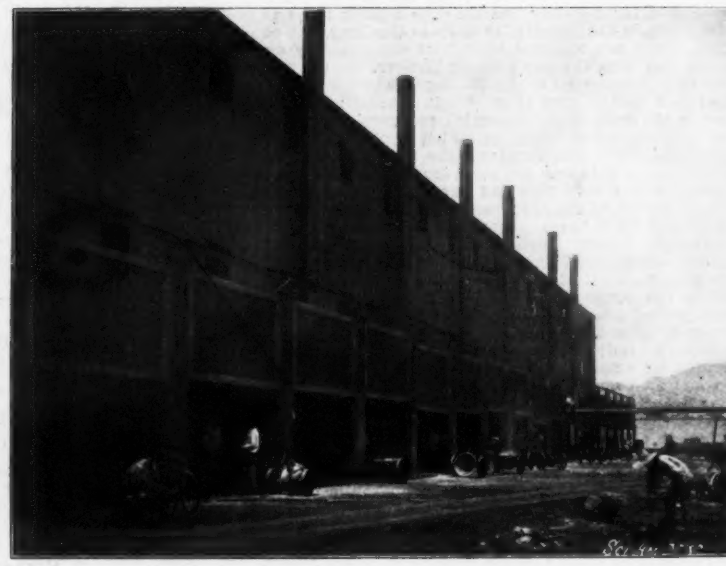
VIEW OF FURNACE-ROOMS.



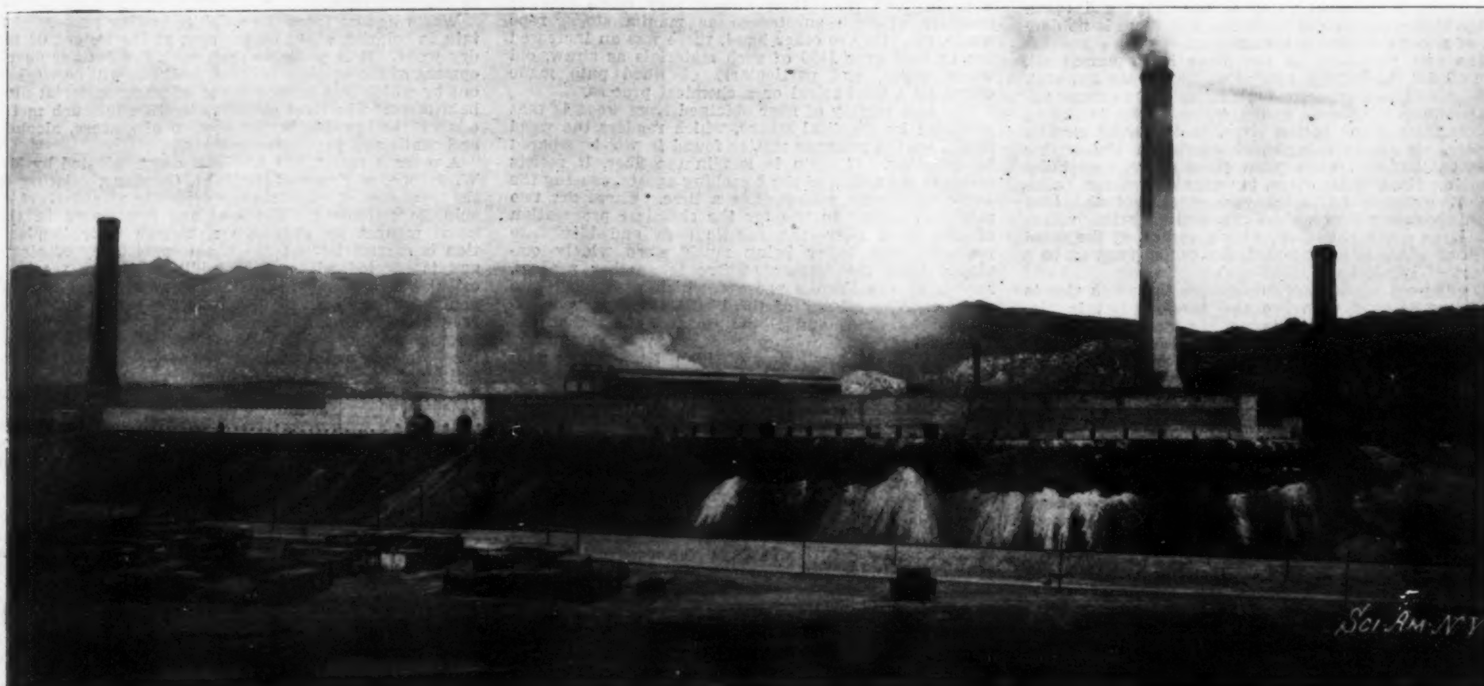
SLAG-TRAIN AT SEPARATOR.



BULLION SWEAT FURNACE.



A NEAR VIEW OF THE FURNACES.



GENERAL VIEW OF THE BLAST-FURNACES.

A TEXAN OIL-BURNING BLAST-FURNACE PLANT.

NEW EL PASO, TEXAS, OIL-BURNING BLAST FURNACE PLANT.

By C. W. Clapp, C. E.

Of the smelters owned and controlled by the American Smelting and Refining Company, the one recently constructed at El Paso, Texas, is the most modern plant of its kind in the country. While this plant is not the first in size, there being two others of greater capacity, it leads in point of new and modern machinery, in time and labor saving devices, and in being the first to use successfully oil as a power developer.

This new plant, known as El Paso Smelting Works, is located on the banks of the Rio Grande River some three miles from the city of El Paso, upon the site of the old plant which was destroyed by fire in July of last year.

Visiting the plant, one will find a little town of some 2,500 inhabitants, where all is activity and bustle, and an idler is out of place. In the mesa part of the town is the smelting plant, while to the east and north are the offices of the company, the neat residences of the officials, and many good and substantial tenements and business buildings, all constructed by the company, the tenements being leased to the employes. On the west, beneath the mesa and next to the river, are a large number of little Mexican adobe houses which are not owned by the company; these are inhabited by many of the Mexican laborers employed around the plant.

Approaching the smelter and the town from El Paso side, the first things to attract the eye are the four tall smokestacks of brick, the compactness of the town including the plant itself, and the fortified appearance given it by the 3,000 feet of brick flue walls on the south and west sides. The steep rocky hills on the east side add to the fort-like appearance of the town.

This plant, although enormous in capacity, is very compactly built, occupying not more than nine acres. Not a foot is wasted, although the matter of convenience and room for work is plainly shown in every detail.

The capacity of the plant at the present time is 40,000 tons of ore per month, and is capable of indefinite expansion, the general plans being so made as to provide for this.

From the office immediately to the west a few yards, the first building is the blacksmith shop, built of steel, and faced with cream-colored brick. The machine shop stands immediately to the north, and the smaller building of steel for a copper and tin shop adjoins it. The novel thing in the blacksmith shop is the long line of forges, which are operated by a blast conducted by an unseen pipe from the power-house blowers. In the machine shop is arranged neatly the usual machinery to be found in a well-ordered shop of this character. A few steps to the west is the beautiful cream-colored brick structure, the power house, in which is placed the immense machinery that furnishes the motive power for almost everything about the plant and town. This large building, with a steel roof and iron floor, contains four Corliss engines of the cross-compound condensing type aggregating 2,000 horse power. In this room are also two General Electric motors of 500 kilowatt capacity each, two motors of 75 horse power each, and one 2,000 light generator, all of the General Electric make.

From the power house electricity is transmitted to every part of the plant and pump house and for lighting the plant and town. All, or very nearly all, of the machinery is directly connected; all that is not is operated by small electric motors. The engine room also has an overhead electric crane capable of handling fifteen tons.

The boiler room contains six 150 horse power tubular boilers of high pressure, and space is provided for two more of the same type, or for one new type tubular that is being considered.

The pump room contains the large hydraulic pumps for the elevators in the furnace room that lift the ore, coke, fluxes, etc. This room also contains the large fire pumps to be used in case of fire. These are in duplicate; in case of failure of one or more there are others to be called into service. Here, too, are the largest type water pumps for supplying and forcing water to the reservoirs in different parts of the plant and town. These pumps are also in duplicate, and there is no danger of a water famine at the smelter.

The sole fuel used in the plant is Beaumont oil. The oil for the boilers is supplied from a storage tank of 75,000 gallons capacity sunk beneath the ground.

All of the machinery in the entire works, including the pumping plant at the river, is driven by electric motors, no steam being used except in the engine room. All of the power plant given above, except the pumping plant at the river, is under one roof, a building of cream-colored brick with steel roof and iron floor, absolutely fireproof. Connected with the boilers is a large octagonal stack, with a coping of the same brick of which it is composed, and which runs up to a height of 160 feet.

Coming out of the power house on the north side is an immense steel pipe five and one-half feet in diameter, and more resembling a big water main than anything else. This pipe is connected with the big blowers inside the power house by two smaller mains that come out on the north side of the plant and join together at a height of about fourteen feet. It passes east to the end of the power house, thence south about 350 feet into the parallel furnace building where it connects by distributing mains to the furnaces.

The furnace building is now 240 feet in length, and material is ordered for extending it 36 feet farther. It is a steel structure throughout, with the necessary ventilators at the top, and is entirely open on the north side about half way up from the ground. Here are placed the nine furnaces, seven for lead and two for copper, with space for two more.

All the material—the coke for fuel, the charges of ore and fluxes—are carried to the top of the furnaces by electric trolley cars of eight tons capacity, each car being operated by one man. The system here used is the third-rail. The cars are loaded from beneath the freight cars and from a convenient system of bins, after which they are taken to the hydraulic elevators, and then are sent by electric power through a system of switches to any designated hopper, and automatically dumped and returned. Alongside this furnace building is a double-walled, fire-brick flue having connections with each furnace and leading to the immense octagonal stacks, one of which towers to the height of 225 feet. The furnaces are fitted with every convenience for taking the metal from the side and running it into the molds, as well as removing the slag from the front, dumping it into large pots and wheeling it away to be hauled off by the dummy locomotive.

On the south of the furnace building are the large ore and coke bins with elevated tracks where the freight cars are run and conveniently unloaded. The bins containing the different ores, coke and fluxes are so arranged that the loading of the wheelbarrows and cars can be done by gravity and besides this there are many other conveniences for saving time and labor.

The next building on the south is the sampling building and works. This is another steel building fitted out with small roller mills operated by transmitted electric power. There is plenty of room for proper and convenient sampling of ores and their preparation. In the northwest corner of the building is the assaying office. This is a modern, up-to-date office, fully equipped with the best furnaces and all necessary apparatus.

South of the sampling room and ore bins comes a long low steel structure where the fourteen roasters are placed. These roasters are served by a large square red brick smokestack, making the fourth, that carries away the noxious vapors high in the air. These roasters are considered sufficient for some time to come. Here is where many of the grades of the refractory ores are treated, and the refractory elements driven off by the system of roasting whereby the ore is simplified, so to speak, so that it can be treated by the ordinary processes of smelting and fluxing.

Alongside of this building, which is about 400 feet long, is another double-wall flue extending the entire length of the building and leading to the square brick smokestack.

Down under the hill is the pumping plant, operated by electric power, which elevates the large amount of water necessary for the use of the plant and its inhabitants. The water is stored in large elevated tanks about the plant and in the five reservoirs. These lakes, partly natural and partly artificial, are necessary for the proper keeping on hand of the necessary supply of water. Some of them have around them little lawns of green Bermuda grass, which with the trees around them give a freshness and a charm to the plant and town uncommon to such places.

Everything about the plant, from the smallest item to the large Corliss engine, shows a general plan and arrangement of detail that is at once striking and assuring. Every detail as to economy of space, labor, energy and money has been thoroughly planned and scientifically put into practice. The entire grounds and buildings are characterized by the utmost neatness. Every building is absolutely fireproof, and another disaster like the fire of 1901 can never fall on the present plant.

All varieties of ore can be treated at the works except zinc ores, and if they do not run higher than fifteen per cent they can be treated. Large shipments of New Mexico ores are at present being treated at the works, and in a short time ores from Mexico will also be treated.—Specially prepared for the Scientific American Supplement.

[Continued from Supplement No. 1402, page 22464.]

THE UTILIZATION OF WASTES AND BY-PRODUCTS IN MANUFACTURES.*

WITH SPECIAL REFERENCE TO THE DECADE OF 1890-1900.

By Henry G. Kittredge.

PAPER MANUFACTURE.

In the utilization of waste products there is a close relation between the manufacture of paper and that branch of the lumber and timber industry which reduces wood to a fibrous pulp. In fact, paper has always been made chiefly by the utilization of waste materials obtained from the vegetable world, such as rags, old rope, straw, etc. But there was a smaller quantity of cotton rags and other cotton substances used in 1900 than 1890, and a very much smaller quantity of such substances as manila stock, rope waste, etc. On the other hand, there was an increased use in 1900 over 1890 of such materials as straw, old waste paper, and particularly of wood pulp made either by a mechanical or a chemical process.

The best variety of fiber obtained from wood is that produced by chemical means, which renders the wood free from the resinous matter found in wood prepared by grinding. If resin is left in the fiber, it resists strongly the action of the bleaching agents, causing the paper to become yellow after a time. There are two processes chiefly in use for the chemical preparation of the wood fiber—the caustic soda and bisulphite processes—the latter being much more widely employed than the former. There is another process, known as the Franke process, which uses bisulphite of lime. The efficacy of the bisulphite process is explained by Cross and Bevan, to the effect that the chief agency is the hydrolytic action of sulphurous acid, aided by conditions of high temperature and pressure. This process yields a large amount of pure fiber, preserving its original strength, which is not the case when the caustic soda process is used.† German chemists have found that an organic substance containing sulphur can be obtained from waste sulphite liquor in different ways, and the product has been proved to be similar by a corresponding amount of sulphur contained therein.‡

From a sanitary, as well as industrial point of view, the recovery of the sulphite liquor as a waste from wood-cellulose factories is worth the attention and ingenuity of inventors. A prize of 10,000 marks was offered in Germany in 1894 for the best and most successful method of treating waste sulphite liquors so as to prevent the pollution of the streams into which these liquors ran.

There has as yet been evolved no satisfactory application of the waste liquors from the bisulphite process.* Evaporation and combustion involve large losses of sulphur. A more complete regeneration of the sulphur has been the subject of a series of German patents, but the processes are inefficient through neglect of the actual state of combination of the sulphur, viz., as an organic sulphonate. The process of V. B. Drewson consists in heating with lime under pressure, yielding calcium monosulphite (with sulphate and lignone complex in insoluble form). The sulphite is redissolved as bisulphite by treatment with sulphurous acid. This process, however, is relatively costly and yields necessarily an impure lye. It has been proposed to employ the product as a food stuff both in its original form and in the form of benzoate, but its unsuitability is obvious from its composition. A method of destructive distillation has been patented in Germany, but Prof. H. Seidel, of Germany, has investigated the process and finds that the yield of useful products is much too low for its economical development. Fusion with alkaline hydrates for the production of oxalic acid is also excluded by the low yield of the product.

A number of German patents have been taken out for the recovery of the organic matter from waste sulphite liquor and for the production of useful products therefrom. Many of these patents have for their object the extraction of a tannin material as size for paper. By this latter process the solution containing tannin (simply waste lye) is added to the pulp in a beating engine, and, when well mixed, a solution of gelatine is added, the result being an insoluble coating of tannin size upon the fibers. In a later patent the addition of resin size is recommended. According to a German patent of 1891, a means of osmosis is proposed for obtaining a purer form of tannin suitable for tanning hides.

In the opinion of Prof. H. Seidel, the application of the waste liquors from the bisulphite process to tanning purposes appears promising from the fact that 28 per cent of the dry residue is removed by digestion with hide powder. This application, however, he says has been extensively investigated, but without practical success. Various uses are suggested by the viscosity of the evaporated extract. As a substitute for glue in joinery work, in bookbinding, etc., it has proved of little value. It is applied to some extent as a binding material in the manufacture of briquettes, and also as a substitute for gelatine in the petroleum industry.

According to Dr. L. Gottstein, Breslau, Germany, the isolation from the waste waters of the bisulphite process of a suitable tanning material for use in the leather factories has not been so successful as was at first expected; and the attempts to make alcohol, acetic acid, and oxalic acid have not given satisfactory results. He says, too, that all the attempts to produce usable material by the dry distillation of the solid residue from the liquor have also failed. The daily production in Germany of about 1,000 tons of sulphite pulp means about ten or twelve times that amount of liquor, having from 9 to 10 per cent solid residue, giving about 1,000 tons as the daily production of this substance. It is on the average about one-fifth inorganic and four-fifths organic in composition.

A German patent has been granted for the production of a dressing compound for textile material, which the inventor calls "Dextron." The liquor is neutralized, and then concentrated by means of evaporation and saturated with magnesium sulphate. The solution of this salt throws out, in the form of a scum upon the surface, the so-called dextron, which is collected, dried, and ground. The material, it is said, can be largely used in the place of dextrin. It contains tannin and possesses antiseptic properties, and is sold chiefly to cotton-weaving mills and calico printers.

Prof. H. Seidel's application of soda salt from the lignone sulphonic acid as a reducing agent in chrome-mordanting wool and woolen goods is claimed to be successful in practice, and its industrial development shows, it is said, satisfactory progress. The product is known as ligno-rosin. Dr. Gottstein, in a recent address, observes that sodium lignin-sulphonic acid (ligno-rosin) as a substitute for tartaric or lactic acid for mordanting wool plays, in proportion to the great amount of sulphite liquor produced, a very small role in its utilization.

Waste liquors from the sulphite boiling process contain in solution about 50 per cent of the weight of the dry wood. It is probable that, with the further development of the sulphite process, methods will be worked out by which this large amount of waste material may be utilized. The most obvious direction for such methods will be toward the preparation of glucose, alcohol, and oxalic and pyroligneous acids.†

A process (patented) has been communicated by Mr. W. Trippe, of Essen-on-the-Ruhr, Germany, relating to the treatment of waste liquors from the manufacture of sulphite cellulose.‡ The lyes are inspissated in the usual manner by evaporation, though their inspissation is carried beyond the usual consistency of sirup, and is effected without the addition of any reagents calculated to promote the elimination of the solid compounds of sulphur. By the time the sirupy mass has been brought to contain only about 20 per cent of water, the sulphur compounds of the lye begin to decompose, yielding mainly sulphurous acid, and also, secondarily, some other volatile compounds of sulphur, such as mercaptanes, mercaptides, and the like. These gasiform products which, if desired, may be drawn off, may be utilized in a variety of ways, say in the manufacture of sulphurous acid, sulphuric acid, or compounds of such acids, or, if desired, in the production of sulphur and other sulphur compounds. The moment decomposition begins, a froth forms on the surface of the liquor, as a result of the first escape of gas, in the form of bubbles. The formation of froth discontinues after a resistant skin has developed on the surface. This is blown or distended, and hinders the rapid escape of the gases, thereby retarding the progress of the decomposition.

The physical effect—and also the chemical change—may be expedited by additions of organic substances capable of checking the formation of the resistant

* Census Bulletin 190.
† Industrial Organic Chemistry, 3d edition, Sadtler.
‡ Journal of Society of Chemical Industry, vol. 17, page 596.

* H. Seidel.
† The Chemistry of Paper Making, Griffen & Little, 1894.
‡ Paper Trade Review, July 5, 1901.

skin already mentioned. Among such substances may be mentioned the different varieties of pitch and similar tar products, resin, carbohydrates, hydrocarbons, glues, organic acids, and the ethers of such acids. These additions of organic matter are particularly effective when made in the form of solutions, the preferable solvents to be employed being benzine, petroleum, and other hydrocarbons or their derivatives. In order to expel the sulphur compounds, inspissation should be carried on to a point at which there shall remain behind a mass of paste which while hot (or warm) is, indeed, plastic and kneadable, but which, when allowed to cool, becomes hard and brittle and can be broken up or pounded into fragments, like resin, for example. Inspissation may be carried on even beyond this point, until there remains a perfectly dry, sandy residue. It is a somewhat remarkable fact that this residue still retains the viscous or adhesive property which it had been observed to possess in those forms in which alone it has been hitherto known to occur. The only forms in which, until the present time, the mass was known to be adhesive was the liquor, sirupy form, either cold or warm, and the kneadable form which the mass assumes when cold.

The residue, if not evaporated right down to desiccation, forms, while yet warm, a moldable mass or paste, which, however, has lost none of its adhesive qualities; and this adhesiveness subsists both when the residue is moistened, as it would in the case of glue, and when it is heated, as in the case of resin or pitch, so that it may immediately be used as a substitute for any of these substances. The development of these qualities may be favored by superadding to the mass, while yet in the process of formation, such other substances as are capable of increasing its adhesiveness; the nature of such additions, of course, depending upon the particular purpose which the adhesive mass is intended to serve. Among such substances, in addition to the organic compounds already referred to as agents for the prevention of skin formation, are the various albuminoids, albuminates, terpenes, resins, and tar products.

As a result of these additions, the residue will more closely resemble such adhesive substances as resin, pitch, or the like; but if the residue is readily soluble in water, the additions will be apt to diminish its adhesive property. Where the residue is treated with a view to its employment as a substitute for glue, resins, or the like, it is expedient to determine the degree of inspissation beforehand, with due regard to the qualities which the residue in its final form is desired to possess. Where, for example, it is to be used as a substitute for glue, inspissation should not be carried on as far as it would have to go if a substitute for resin were required.

As the residue has been freed from sulphur compounds, it is not only perfectly harmless to vegetation, but is fitted for use as manure, or as an addition to manure, by reason of the assimilable organic substances and of the lime in a finely divided state which it contains. Where, on general grounds or from local considerations, this treatment of the residue—which economically speaking, is unobjectionable—is not deemed desirable, it may immediately be used as fuel; in which case the mineral ingredients of the lyes—in particular calcium or magnesium—should preferably be eliminated either before or during the process of inspissation, it being immaterial what particular mode of elimination is adopted.

A process of utilizing waste sulphite liquor and product therefrom has been very recently invented by Alexander Mitscherlich, of Freiburg, Germany, and patented in the United States.* The process is chiefly intended to collect these liquors and utilize their properties so as to yield products of increased commercial value, and extend their usefulness to various purposes other than the manufacture of paper pulp. The process is based upon the previous removal of the inorganic constituents of the spent liquor by an addition of lime and the subsequent separation of the organic bodies by dialysis or osmosis. A new article of manufacture also obtained from the spent liquors is a tanning agent.

A process of obtaining an adhesive substance from sulphite liquors suitable for sizing and mordanting was the subject of a patent in 1895.†

The use of a neutralized solution of the bisulphite waste waters free from the lime precipitates, as water for field irrigation, has proved a failure.‡ The gummy liquor stops the pores of the ground, preventing filtration, and rendering the leached waters from fields on which it is used dark and ill smelling. On this account the storage of the liquor in cemented basins is not to be recommended, since, on standing, the basins became leaky and the surrounding water contaminated.

As to the durability of paper produced wholly or partially from wood cellulose, opinions are still divided, some holding that rag substitutes should never be used for paper that is intended to remain in good condition for long periods. In the case of unbleached cellulose and ground wood no doubt seems to exist, as these materials are known to deteriorate rapidly. The question of durability, therefore, it would seem, can be definitely decided only by a series of systematic experiments extending over a long period of time.

A writer in the Journal of the Society of Chemical Industry for August 31, 1896, makes some comment on the durability of paper made from wood pulp, to the effect that pulp prepared by grinding wood contains ligneous and other incrusting matter, and the composition is similar to that of the wood itself. Paper made from this pulp turns brown, and becomes brittle and rotten when exposed to the action of light and air for any length of time. Pure wood-cellulose fibers are not affected by light or air, hence it is assumed that the above results are owing to the presence of the incrusting matters. Paper made from brown pulp is less sensitive to light, since the incrusting matter is partly removed by steaming and lixiviating. Cellulose made from wood by boiling with soda stands the action of light and air without turning brown, although it undergoes a change of another kind.

Some years ago blotting paper was made by an American firm from soda wood cellulose, but it was admitted by the makers that after a time the paper lost its absorbing qualities and in a few years it became rotten, the fibers becoming again incrusted. A test of blotting papers several years old confirmed this view. From this and other observations, it is suggested that certain cellulose pulps are liable to return by degrees into the state of the original ligneous fiber. Whether papers made of sulphite fiber will remain unaffected in the course of years, is as yet uncertain, although some paper makers assert that sulphite fiber is as suitable for documents as is rag fiber.

An English patent has been granted to W. J. Ward, Manchester (English patent 15,986, September 8, 1900), for the manufacture of waterproof paper, also mineral oil, grease, soap, and the like. According to this patent the spent liquor from the sulphite treatment of wood is evaporated down to 30 degrees Tw., with a definite proportion of sodium or potassium bichromate. It is then treated with more bichromate in a steam-jacketed pan, while paraffin, wax, or the like, previously melted with 2 or 3 per cent of tallow, or 1 per cent of boiled linseed oil, is mechanically incorporated. Finally the product is mixed with the paper pulp in the beaters at a temperature not exceeding 80 degrees F. A mineral grease or soap is obtained in a similar way by removing the calcium salts from the spent liquor and adding 50 per cent or more of mineral oil, with 1 or 2 per cent of tallow, instead of the wax.

The recovery of soda is a valuable side product in the manufacture of paper. The alkaline liquors in which rags and other paper-making material had been boiled were at one time allowed to run to waste. This is no longer permitted in economically conducted mills, as the alkali can be recovered in the form of a carbonate, by the evaporation of the waste liquors and the ignition of the residues, after which this carbonate can then be causticized and prepared for renewed use. The soda, during the process of boiling with the paper-making materials, takes up a large amount of noncellulose fiber constituents, such as resin, coloring matter, and silica. These on evaporation and ignition become either carbonate or silicate.*

A patent was taken out in 1893 (United States patent No. 492,927) for the manufacture of paper board, box board, and the like from old newspapers or other similar printed white paper. In the manufacture of the article preference was given to printed newspaper or other printed paper possessing the characteristic properties of the ordinary paper upon which newspapers are printed on account of its cheapness, its freedom from size, and its softness. Old copies of newspapers or the overissues can be bought up at low rates and utilized for this purpose. A new article made is a paper board manufactured from old newspapers ground to a pulp and having the permanent particles of the printer's ink minutely subdivided and uniformly distributed throughout it so that a smooth and even tint is imparted to the board.

According to the present census 356,193 tons of old waste paper were consumed in paper manufacturing, and crude paper stock, fit only to be converted into paper, was imported and entered for consumption in 1890-1900 to the value of $3,261,407.21.

SLAUGHTERHOUSE PRODUCTS.

Slaughterhouses furnish a multitude of by-products which are utilized on a commercial scale of some importance. The products of the gray brain matter of calves are now employed in the treatment of affections of the nervous system,† known under different names, as, for example, neurasthenia (nervous debility; nervous exhaustion), agoraphobia (a dread of crossing open spaces, city parks, etc.), chorea (nervous disease; St. Vitus's dance), psychosis (mental disorder; insanity).

It was not until 1870 that the preservation of pork and beef products was practically carried further than the air-drying and salt-pickle curing of hams, bacon, mess pork, and dried and corned beef. The customary practice at that time of shipping the cattle from the West to the eastern markets, to be there slaughtered, entailed a heavy shrinkage in weight, and other losses. It was about this time that there was a commercial demand from glue manufacturers for a part of the slaughtered offal, the disposition of which had become a source of expense, and a demand from fertilizer manufacturers for such parts as were not wanted by the glue maker opened the way for a utilization of by-products, which was greatly facilitated by the introduction of a system of ice refrigeration and transportation. This made it possible to slaughter live stock in the West and ship the edible portions to the consumer at distant points, allowing the conversion of the offal at the point of slaughter into by-products, such as soap, glue, fertilizers, etc., thus saving the cost of transportation as part of the live animal.

The blood from the slaughtered animals has long been utilized for the production of albumen, for the use of the calico printer, the tanner, the sugar refiner, and others. The bones of animals are used for a score of different purposes; those coming from the cooked meat are boiled, and the residual fat and gelatin are extracted; the former is used in the manufacture of soap, and the latter, for various objects, as transparent coverings for chemical preparations, etc.‡

The bones from the feet of cattle are used in the manufacture of tooth brush handles, knife handles, chessmen, and for whatever purpose ivory is used, since the hard bone takes a very high polish. The knuckles from these bones are cut off and used in the manufacture of glues and for fertilizer. The tip of horns is sawed off, and the horn is split and pressed out into a flat plate under heat and pressure. These plates are used in the manufacture of combs, backs of brushes, large buttons, etc. The tip of the horn is made into mouth pieces for pipes and various other articles. The horn scrap is used for fertilizer.

Hoofs are sorted into three grades: White hoofs, which are sent to Japan and there used in the manufacture of various ornaments; striped hoofs, which are worked up into buttons and horn ornaments; and black hoofs, which are used in the manufacture of cyanide of potassium for gold extraction, and also ground up to make fertilizer for use of florists, grape growers, and others.

Neat's-foot oil is extracted from the feet, and various oils are taken from different portions of the animals. These all have a high commercial value.

A patent was granted in 1898 to Alexander Mitscherlich, of Germany (United States patent No. 602,237), for a process and apparatus for converting bones at a small cost into useful adhesive matters; at the same time certain fermentable substances which can be used for producing alcohol and phlegma (distiller's wash) are by-products of the process. The process consists essentially in dissolving waste bony matter, such as horns, hoofs, hair, and the like, and precipitating this solution by the tanning principle found in the lyes obtained in the manufacture of sulphite cellulose.

A valuable branch of the utilization of fat of beef and hogs is the manufacture of substitutes for butter, toward which experiments have been made with more or less promising results within the last thirty years. In 1870 a French chemist found that carefully washed beef suet furnished a basis for an excellent substitute for dairy butter. Since then a large industry has grown up in the manufacture of such articles as butterine and oleomargarine.

An important article obtained from fat is glycerin, which is brought into commerce as refined or distilled glycerin, or as an element in glycerin soaps, toilet preparations, roller compositions, etc. Glycerin was once a waste article produced in the manufacture of candles from palm oil. It was found necessary to abstract this substance, as it caused an unpleasant smell when the charred end of the wick went out. This substance was at first allowed to float off into the river, the loss per week at some factories being estimated as high as $2,000. This loss has been eliminated since the valuable qualities of the by-product have been ascertained. The application of glycerin in medicine, and for technical purposes, has made it important to extract and purify this article whenever possible, and now its value, in relation to other fat constituents, is great.

The two methods of saponification by which glycerin has been obtained on a large scale, are the processes of Wilson and Payne of decomposing the fats by superheated steam and after distillation, and the lime autoclave process of Milly.*

Dr. S. P. Sadtler, in the third revised edition of his work on organic chemistry, says:

"It is obvious that in soap making, as numerous quantities of the fats are decomposed, corresponding quantities of the glycerin go into the spent lyes. It is only very recently that it has been attempted to recover this glycerin, and no perfectly satisfactory process seems as yet to have been adopted. More practical, in the opinion of those qualified to judge, seems to be the idea recently put forward to deglycerinize all fats before saponifying them. The process of Michaud Freres, of Paris, realizes this idea very successfully."

A suggestive invention was patented in 1898 (Letters Patent No. 602,725) for the recovery of glycerin from tank waters, that of utilizing the waste products of slaughterhouses and rendering establishments. Tank water, as is well known, is a by-product of rendering establishments produced in cooking, under pressure, the scraps of meats, bone, sinews, lungs, intestines, and other nitrogenous matter containing more or less fat; such cooking being continued for several hours, until the substances in the tank are decomposed to a great extent and the fat liberated. A large part of the nitrogenous matter remains in solution in the liquid produced from the solids introduced into the tank and from the condensed steam. The fats rise to the surface, while the undissolved matter, to a great extent, settles to the bottom of the tank. The liquid lying between the fat and the solids, or "tankage," in the bottom of the tank is known as "tank water." After the fat has been skimmed off, the water is drawn off from the tankage and disposed of in various ways. This tank water was for many years discharged into the sewers, although it is known to contain valuable nitrogenous matter, and even at the present day it is thus disposed of in almost all houses of small capacity.

There was imported into the United States for the fiscal year 1899-1900, crude and refined glycerin to the value of $2,128,670.50.

Red bone marrow is a valuable by-product of the slaughterhouses. The marrow found in young animals has the most active properties, and is obtained from the finer medullary substances of the rib bones of young cattle, and contains less fatty principles than that derived from the long bones, and must be extracted immediately after the animal has been killed, else molecular death of the marrow ensues. It unites with the unaltered proteids of the blood, and is of the highest nutritive value. Finely comminuted calves' ribs, being richest in bone material, are selected from recently killed animals and macerated or digested in chemically pure glycerin for several days, until extraction is complete. The medullary glyceride is then strained or filtered off for immediate use as a palatable preparation. This product stimulates the formative processes and increases the rate of production of the red blood corpuscles.

Gelatin, or, in its lower grades, glue, is a by-product of the slaughterhouse, as the bones of animals contain on an average nearly one-third of their weight of organic constituents, which may be extracted by boiling and converted into gelatin or glue. This, though inferior in adhesive power to that prepared from animal skins, is of much commercial value. The soft bones of the head, shoulders, ribs, legs, and breast, and the bony core of the horns of horned cattle, and especially deer's horns, yield a larger quantity of gelatin or glue than the hard thigh bones and the thick parts of the vertebræ, which are principally composed of calcium phosphate and require a more prolonged treatment to extract the gelatin-making constituents.† The most important gelatin-yielding material is the hides of animals, obtained from the trimmings of ox, sheep, and calf skins, the refuse of the beam house, and scraps which have been softened and the hair removed by liming to get them in condition for boiling. The epidermis and the underlying fat tissue are not

* United States patent No. 681,241.
† United States patent No. 550,712.
‡ Dr. L. Gottstein, Breslau, Germany.

* Industrial Organic Chemistry, by Sadtler; Text-Book of Paper Making, by Cross and Bevan.
† Journal Society of Chemical Industry, vol. 17, page 738.
‡ Good Words, vol. 17, page 156.

* Industrial Organic Chemistry, Sadtler.
† Industrial Organic Chemistry, Sadtler.

valued as glue stock. For gelatin, calves' hides are the most valuable, forming a special article of commerce after being limed and dried.

The following statistics pertaining to the manufacture of glue are from the 1900 census:

	Total number of pounds.	Made from hide trimmings, etc., fur, or neat's-foot stock.	Made from bone or bone liquor
		Pounds.	Pounds.
Glue establishments	34,984,448	29,036,901	3,109,165
Slaughtering establishments	34,516,761	12,780,832	20,183,562
United States	69,501,209	41'817,733	23,292,727
	Made from cattle, hogs, etc.	Made from fish skins and waste.	Made from other materials.
	Pounds.	Pounds.	Pounds.
Glue establishments	66,666	2,731,156	40,560
Slaughtering establishments	1,282,367	270,000	....
United States	1,349,033	3,001,156	40,560

The value of imports of hide cuttings, raw, and all other glue stock and hide rope entered for consumption in the United States during the fiscal year of 1899-1900 was $1,207,572.03, and the value of imports of glue was $526,544.05.

Slaughterhouse by-products that are utilized include gelatin, glue, fertilizers, hair, curled hair, bristles, blood, neat's-foot oil, bones, horns, hoofs, glands and membranes, out of which are obtained pepsin, thymus, thyroids, pancreatin, parotid substances, suprarenal capsules, etc.; soap stock, glycerin from tallow, brewer's isinglass, albumen, hides, skins, wool, intestines.

(To be continued.)

PRESSURE INDICATOR.

SOME of our readers may have given more than passing attention to a clever pressure indicator which was exhibited by Mr. J. E. Petavel, the inventor, at the soirées of the Institution of Civil Engineers. The feature of the indicator or manometer is the absence of a spring. There is a cylinder with a piston and piston rod somewhat after the usual kind, but in place of a spring a tube of some suitable metal is used. It is the compression of this tube longitudinally that gives the indication. The compression is, of course, very small, as evidently the stress must be within the elastic limits of the material, or permanent set would be established. In order to magnify this small movement to a measurable amount, a concave mirror is mounted on the top of the rod, with a fulcrum very close to the point of pressure. A beam of light is reflected from this mirror in the usual way, and leaves a record on a rapidly-moving sensitized surface. This manometer was designed for the measurement of the pressure of explosives, measurements upon the practical and physical value of which it is unnecessary to insist here. We may, however, recall to our readers

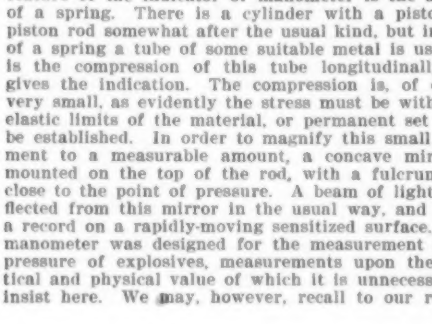


FIG. 1.—EXPLANATORY DIAGRAM.

that one of the most debated points in the theory of gas engines depends not a little for its solution upon the exact determination of the pressures at various instants of an exploding mixture. We refer, of course, to the now almost discountenanced "after-burning," and the more probable explanation of the phenomenon which is to be found in a variation of the specific heat of the gases at the high temperatures of explosion.

The arrangement of Mr. Petavel's apparatus for measuring the pressure of explosives will be understood from the accompanying diagram, Fig. 1. The cylinder, *C*, is screwed into the chamber in which the explosive is fired. A piston, *P*, fits this cylinder gas-tight. A tube, *S*, fits the cylinder freely, and one end of it abuts against the lower side of *P*, while the other end presses against a shoulder in the cylinder. *P* carries a piston rod with a stirrup knife edge, *b*. A second knife edge, *a*, is fixed to the cylinder. Between these two knife edges is a lever carrying the concave mirror, *m*. A steel wire, *c*, stretched nearly to its limit, pulls on the opposite end of the lever. *L* is the source of light; *D* the recording drum. When the explosion takes place, *P* is driven down a very short distance into the cylinder, compressing the tube, *s*, depressing the fulcrum, *b*, and allowing the wire, *c*, to tip the lever, and so raise the point of light on the drum. As the pressure falls, the order of events is reversed. The tube expands back to its original length, and the mirror returns to zero.

The section of an actual apparatus to quarter scale is shown in Fig. 2. Most of the parts will be at once recognized, but the mirror lever, *L*, is in a different position. The only essential point to know is that the two knife edges, *a* and *b*, Fig. 1, are usually 1-16

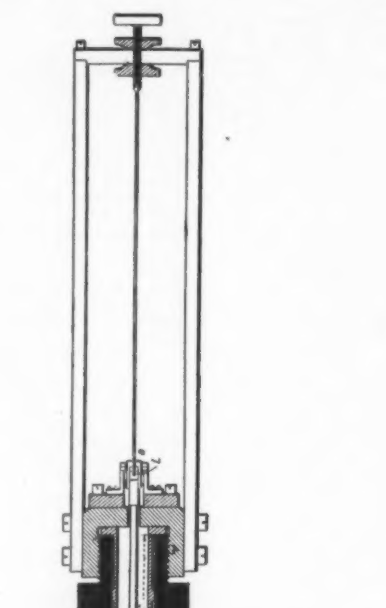


FIG. 2.—SECTION OF PRESSURE INDICATOR.

inch apart. Adjustment is provided for bringing them closer, but it is found unnecessary. The wire is very long in proportion to the slight movement it has to make, and being stretched nearly to its elastic limit, its extension and contraction are practically constant. The spigot, *D*, of the cylinder, is a close fit in the wall of the explosive chamber. The piston, *P*, fits

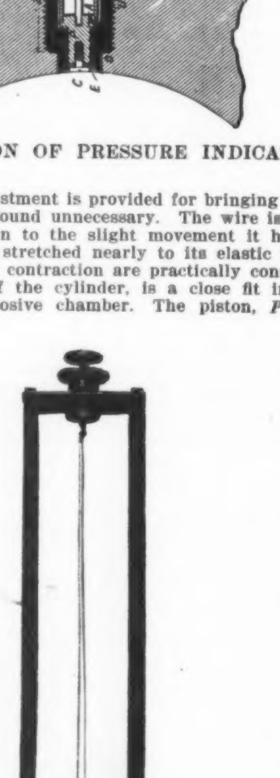


FIG. 3.—PRESSURE INDICATOR FOR ORDNANCE.

the cylinder closely. A leather washer is attached to it by the screw, *C*, and to the cylinder by the ring, *E*. The end of the piston projects about 1-100 of an inch above the face, *H*, and it can therefore move back without straining the leather. The spring or tube is marked *s*, and the method of fixing it is sufficiently obvious from the drawing. This apparatus, as drawn, has been used for pressures from 1,000 pounds to 10,000 pounds per square inch; for pressures higher than this a thicker "spring cylinder" is used; for lower pressures the spring cylinder is made thinner, and the area of the piston larger. At the Institution, Mr. Petavel had an apparatus which indicated quite freely the pressure—not more than 20 pounds probably—produced by a bicycle tire inflator.

In Fig. 3 an artillery instrument is illustrated. It is thought that it will be found exceedingly useful in the study of ballistics, not only as a means of testing the explosives used, but as a means of obtaining an indicator diagram of the gun under normal working conditions. It has already been experimented with for this purpose with very satisfactory results. Of the other uses of the instrument there are one or two sufficiently obvious. It is evidently excellently suited for measuring the pressure of gases under compression. Physical research demands that records should be made at enormous pressures—pressures so high that no type of spring recorder is suitable. For such purposes it would be admirable. For gas engine experimenting, too, in those cases where cumbersomeness is of small importance, it should be very valuable. It is far from impossible that it may prove eminently satisfactory for high-speed engines of all sorts, as the absence of moving parts will obviate altogether the usual troubles from inertia.

The film on which the deflections are photographically recorded is wound on a drum, which is kept in rapid rotation by an electric motor, the usual devices being used to regulate and measure the speed. The drum is inclosed in a light-tight box; a long, narrow slit—about 1-32 inch in width—runs the entire length of the box parallel to the axis of rotation. One of the filaments of an incandescent lamp is focused by the mirror on to this slit, forming a fine straight line perpendicular to the axis of rotation and to the slit. The sharp point of light thus formed on the film moves from right to left as the pressure increases. To secure the quality and intensity of light which is necessary, the lamp is run at twice its normal voltage at the moment of the explosion. To avoid the blurring of the zero line the light is cut off an instant later, and the zero marked in when the products of the explosion have had ample time to cool to atmospheric temperature. The gage is calibrated by hydraulic pressure.

Commenting on some diagrams, Mr. Petavel said in a paper read before the Manchester Literary and Philosophical Society.

(1) The time required to reach the maximum pressure, namely, 0.058 second, is not far from that which would be required with the same mixture at atmospheric pressure.

(2) The ratio of explosive of initial pressure has been increased. At or near atmospheric pressure the ratio for this mixture would be about 7; in the present case it is 8.6. This fact is due to three causes which work simultaneously, namely: (*a*) The departure of gases from Boyle's law; (*b*) the relative decrease of thermal loss during the time occupied by the combustion; (*c*) the increase in the absolute temperature at which dissociation would take place.

(3) The rate of cooling has greatly decreased.

The quantity of heat dissipated per unit of cooling surface increases with the temperature interval and with the pressure of the gas, but not at the same rate as the latter. The heat developed, on the other hand, is simply proportional to the pressure.

By increasing the pressure from 1 to 70 atmospheres we increase the heat generated in a given volume seventy times, but we do not increase the rate at which heat is dissipated in anything like the same ratio. The increase of efficiency, which, in the case of gas engines, has always been connected with the use of high initial pressures, is mainly due to this cause. It is also to some extent due to the higher temperature obtained and to the smaller dimensions of the moving parts.

One more point deserves attention. It will be noticed that 0.05 second after firing the rate of rise of pressure suddenly increases, and becomes over nine times as fast as before. For the less explosive mixtures this change in curvature does not occur, the curve of rise of pressure being similar to the cooling curve, only, of course, much steeper. It is worthy of note that the change of curvature occurs when the gas is at a mean temperature about equal to that at which spontaneous ignition would take place. A similar result would therefore be obtained if we heated the gases by the combustion of a certain portion of them until the entire bulk was at the "flash-point:" the combustion would then take place simultaneously throughout the entire mass, resulting in an almost instantaneous rise to the maximum temperature and pressure.

This sudden increase in the pressure, due, as Mr. Petavel explains, to the elevated temperature, is well worthy the attention of gas and oil engine makers. It would be interesting to know if the same phenomenon occurs in a cylinder with a moving piston.—Engineer.

WHAT IS STEEL?

THIS question has been a familiar heading to dozens of letters in the Sheffield Daily Telegraph during the last few weeks. It arose out of a prosecution by the Cutlers' Company. In an action brought against a firm of local manufacturers, it was contended that the word "steel" was applied by these manufacturers to forks which were not made of steel. The Cutlers' Company did not succeed in their action, the stipendiary magistrate of Sheffield upholding that the metal was steel, though of a very low grade. The decision caused considerable dissatisfaction in steel circles, and the necessity for laying down a clear definition of what does constitute steel was energetically set forth by various steel manufacturers, chemists, and others. The Sheffield Society of Engineers and Metallurgists took up the question, and under its auspices Prof. J. O. Arnold, head of the Metallurgical Department of the University College, delivered an exhaustive lecture

recently, taking for his text the form of the question used in the newspaper, "What is Steel?" The interest in the subject was shown by the large attendance. The lecture was illustrated by lantern slides.

Prof. W. Ripper, head of the technical department of the College, and President of the Society, was in the chair, and among the audience were the Master Cutler of Sheffield, Mr. A. J. Hobson; Mr. A. R. Ellin, ex-Master Cutler; Dr. Hicks, President of the College; Col. Hughes, Law Clerk to the Chamber of Commerce; and many manufacturers, steel managers, and others. After a very able and exhaustive lecture, Prof. Arnold pointed out that the legal aspect of the situation created by the stipendiary's decision was about as bad as it could be. It rendered the Cutlers' Company incapable in most cases of bringing to book the manufacturers who struck the word "steel" on articles made of malleable cast iron or "Lucas" metal, and when such cast iron articles were cast from a pot there was no legal reason why they should not be marked "warranted Sheffield crucible cast steel." The professor's practical suggestion for remedying the difficulty is, first to agree as to what is steel and what is not steel, to get such a classification adopted by a thoroughly representative and influential commission, and to then have the recommendations of the commission embodied in an Act of Parliament, so that steel makers may be protected from the sale of "Lucas" metal as steel or steel castings, just as butter makers were now protected by law from having margarine sold as butter.

The Master Cutler, in proposing a vote of thanks to Prof. Arnold, said that any effort to promote honest trading would have his heartiest sympathy. It was no use arriving at a definition of steel unless they were prepared to go a step further and give it a legal effect. For that purpose they must be willing to put their hands in their pockets.

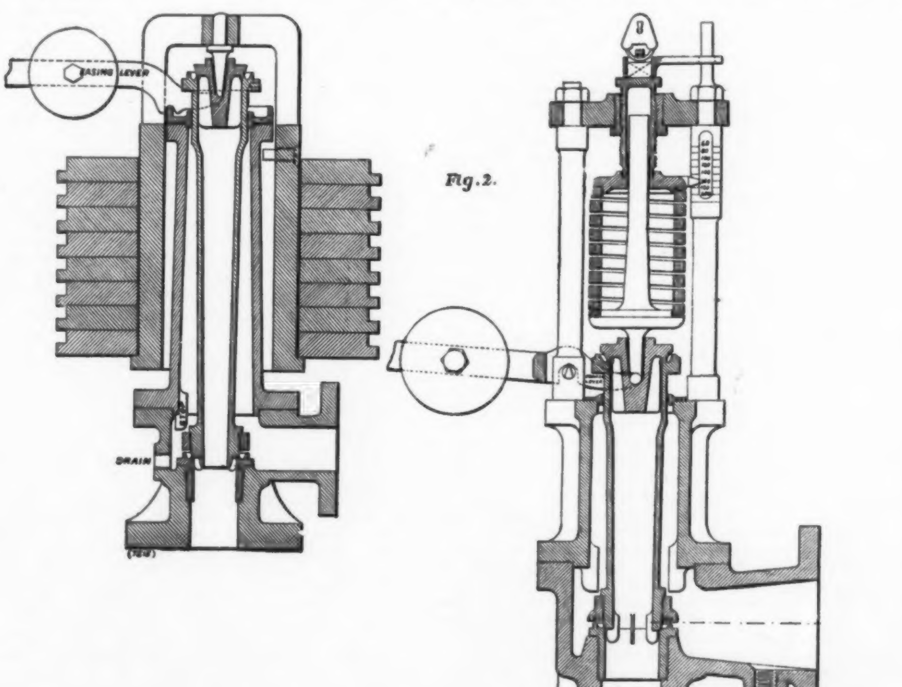
DOUBLE SAFETY VALVES.

THE double safety valves we illustrate on the present page have been devised by Messrs. Cockburns, Limited, of Clydesdale Engineering Works, Cardonald, Glasgow, to reduce the enormous amount of deadweight required for safety valves for high pressures, particularly for water-tube boilers. Fig. 1 shows a dead-weight valve and Fig. 2 a spring-loaded valve.

The special feature of novelty is the arrangement for counterbalancing the weight of the inner brass tube. It is carried in a fork at the end of a lever, which, at its other end, carries a counterweight which can be adjusted along it to ensure that the inner tube follows the upper valve. The lower end of the tube is open, and has a valve surface around it, corresponding to a fixed seat in the main casting. The upper end of the tube, which is of larger bore than the lower end, is closed by a valve, which is loaded (Fig. 1) by deadweights in the usual way. The steam pressure tends to raise both the tube and the upper valve; but the upper valve, from its larger area, would naturally lift first. The tube, however, follows it simultaneously, and is held against the upper valve by the counterweighted lever, and also, of course, by the steam pressure on an area corresponding to the upper valve seat. The steam then escapes at the lower valve seat. If, however, the steam pressure is sufficient to raise the lower valve until the ring round the tube meets the stop, the tube can no longer follow the upper valve, which then opens and affords a second outlet. The two valves are quite independent of each other; and if either should stick, it will not affect its fellow.

The makers have found it an advantage to contract the lower end of the tube, making the inlet sufficient to discharge all the steam possible to be generated with the consumption of coal of 25 pounds per square foot of grate area. The valve shown is suitable for a boiler with 20 square feet of grate area and 200 pounds pressure of steam per square inch. The upper and lower valves have the same area. A pair of 2½-inch ordinary valves for 200 pounds pressure requires 2,000 pounds of deadweight, while with valves of similar size, of the design shown in Fig. 1, only 1,000 pounds of deadweight are required. Further, only a single pipe is needed for the emission of the waste steam.

The arrangement shown in Fig. 2 only differs from that in Fig. 1 in that it is spring-loaded.—Engineering.



DOUBLE SAFETY VALVES.

THE CYATHOMETER.

As is well known, the level of a liquid in a closed vessel descends or rises to a variable degree according as some of the liquid is removed or more is added. In certain cases, it is useful and even necessary to determine the diminution or increase in the volume of the liquid accurately, and it is in order to meet such a necessity that the "cyathometer" has been constructed. This apparatus is designed to prevent fraud in the retail trade in liquor or valuable liquids. It may be permanently adapted to bottles of all shapes (No. 1) as well as to vats, tanks and casks. It consists of a glass tube fluted internally, of a glass telltale or float provided with two straight springs, and of a solid ball (No. 2).

The tube, which has an aperture at each extremity for the passage of the air and liquid, is suspended in a bottle arranged for the purpose at the time of manufacture, from a band of twisted wires of inoxidizable metal, the extremities of which, after passing through the neck, are united and provided with a lead seal (Nos. 1 and 3).

The operation is simple. When a full bottle is provided with the cyathometer, the telltale is at the upper part of the tube. If a certain portion of the contents be poured out, the levels of the bottle and tube will descend together and the telltale will constantly follow them. If, on the contrary, any quantity whatever of liquid be added, the levels will rise, but the telltale, held by its springs, which are braced against the flutings of the tube, will remain where it was before the addition. It is therefore submerged and marks the precise point where the addition or substitution began. Any fraud will be revealed by the telltale at the very moment at which it occurred. The telltale, having reached the bottom of the tube, the bottle being empty, will be unable, whatever may be done, to ascend to the starting point. Moreover, the arrangement of the apparatus permits of discovering even attempts at fraud.

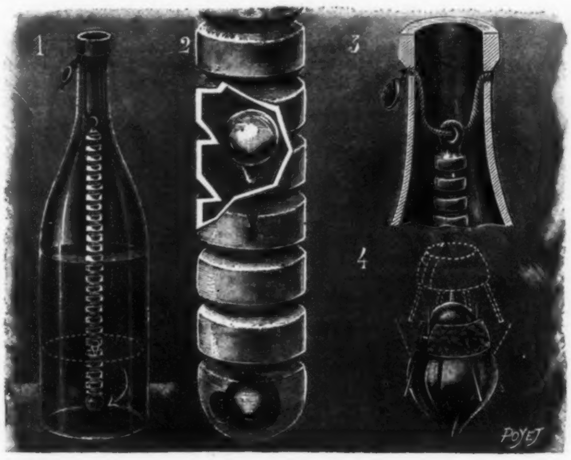
When the bottle, either full or on tap, occupies an abnormal position, its bottom upward, for example, the solid ball falls upon the telltale and holds it in place.

When the cyathometer is adapted to stationary receptacles, such as vats, tanks and casks, the telltale is arranged in a slightly different manner. It then consists of a float and sleeve placed in contact, and each carrying three or four springs pointing in contrary directions, those of the float engaging with the sleeve.

If the control is to occur with a liquid of which the level rises in the receptacle, the sleeve is placed above the float, and, as soon as any of the liquid is removed, the two parts of the telltale separate (No. 4). As the springs of the sleeve bear against the flutings of the tube, it is held exactly at the point where the fraud began, while the float, which in the first place followed the liquid, remains fixed in turn, through the bearing of its springs against the flutings, at the point at which the motion of the liquid stopped or changed its direction. If the control is to occur with a liquid of which the level descends, the sleeve is placed beneath the float, and, in case of an addition, the telltale will operate as described above, but in an inverse direction. In both cases, the positions of the float and sleeve indicate the beginning and end of the adulteration, and the extent of the latter corresponds to the height of the liquid between the two elements of the telltale.

The apparatus lends itself also to the control of movable receptacles of large capacity.

Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.



THE CYATHOMETER.

1. Bottle on tap. 2. Bottom of the tube with tell-tale and solid ball. 3. Method of adapting the apparatus. 4. Tell-tale for stationary apparatus.

A NEW METHOD OF STARTING INDUCTION MOTORS.

IN the Elektrotechnische Zeitschrift Mr. A. Schwartz describes a new method of starting small induction motors. This question has received a good deal of attention of late, and there are at present besides this method three others in use for starting single-phase induction motors. The first of these consists in adding to the main winding of the motor an auxiliary winding placed at ninety degrees from the first, and thrown in circuit by a starting switch. This winding is so designed as to cause a lag in the current flowing through it, and thus produce a more or less perfect rotating field. When a motor has reached its normal speed, the auxiliary winding is cut out. In the second method, the rotor has a winding and commutator similar to that of a direct-current machine. This winding can either be connected in series with the stator winding or short-circuited through properly placed brushes. Either of these methods gives a good starting torque, though with a considerable consumption of current. The third method starts the motor by hand, or in any other way, unloaded. When it has reached its normal running speed, a centrifugal clutch connects it to the driving shaft. The objection to the first two of these methods is the heavy current required to start, particularly under load. The third method is thought to be unreliable, the clutch frequently throwing the motor into gear before it has reached its normal speed, and this will generally bring the machine to a standstill. The method here described makes use of the property of the alternating field to repel a conductor if placed unsymmetrically in this field. In its normal position the rotor of an induction motor is placed symmetrically, so that this repelling force is not evident. By shifting it a little axially and connecting the stator winding to the supply, a strong repulsion becomes evident. With the rotor in this position, it can be started by hand, a slight effort only being necessary. It will then come up to speed, the repelling forces of the alternating field being greater at this time, due to the heavy current flowing in the short-circuiting ring, than the attraction of the magnetic field for the iron core of the rotor. When, however, the rotor has reached its normal speed, the current flowing in its windings is considerably less than at starting, and the attraction of the magnetic field for the core of the rotor is greater than the repelling force acting upon the rotor windings. The rotor is then drawn strongly back into its normal position. This motion is made to effect the coupling of the motor to the driving shaft. The coupling is attached to the end of the rotor shaft, which must be extended for this purpose, and sufficient end play allowed between the bearings for this motion of the rotor. When the rotor is drawn into its normal running position, the coup-

ling engages in the under surface of the driving pulley, and the machine then picks up its load. The action of this arrangement is claimed to be very sure, since the act of coupling does not depend so much upon the motion of the rotor as upon the relative forces acting upon this. The rotor is not drawn back into its running position until the current in its windings has diminished sufficiently to allow the attraction of the field to overcome the repulsion exerted on the windings. In starting the motor, the rotor is pushed axially a short distance, the main switch is closed, and the rotor given a slight motion by hand. The motor at once runs up to speed, automatically throws its coupling into gear, and picks up the load.

ELECTRIC POWER ON THE COMSTOCK.

THERE are few indeed who do not know something of the history of the great Comstock lode of Nevada, famed alike as one of the richest mining discoveries on record and as a unique geological example; immortalized in the annals of romantic literature by many clever writers; and rich in engineering feats. The two miners who, tired of mud-washing for gold in the cañons below, went prospecting up Mount Daviuson, a peak of the Sierra Nevadas, and came across surface deposits of argentiferous ore, little dreamed of the far-reaching effect their discovery would have. It was one Henry Comstock who realized the enormous possibilities of the discovery, who acquired the claims, and who worked them, and the outside world to such advantage that his name became inseparable from the district which remains the Comstock to this day. The presence of the lode was discovered at its outcrop on the mountain; the vein is broad and flat, and inclined at an angle of about 40 deg. The various syndicates who acquired the claims of the original miners proceeded at once to sink shafts so as to intersect the vein at various depths. These shafts varied in depth from about 1,000 feet to 3,500 feet. It is estimated that up to the present time the total value of the gold and silver drawn from the lode aggregates nearly $500,000,000. One company alone—the Consolidated California and Virginia Mining Company—working the vein at the 1,100-foot to 1,800-foot levels, took out in less than ten years metal of the value of over $150,000,000, and paid out in dividends to the shareholders some $75,000,000. Little wonder that men went mad, that adventurers, money-hunters, and unprincipled rogues of all nations should flock to this Eldorado. It is easy to believe in the existence of such a city as Virginia—a collection of wooden shanties peopled with these characters, and as rife in debauchery and vice as Mark Twain has placed on permanent record. It will also be well understood that the miners were not the only gamblers; tricks and fraud in dealing with stocks were rife, shares rose in eight months to 550 times their original value, and in the surrounding towns rich and poor of all ages and of both sexes were gamblers.

The outcrop on Mount Davidson was discovered in 1859. In 1874 the boom commenced with the gigantic production of the Consolidated Virginian Mine. From this mine alone the yield averaged over $3,000,000 per month for three years, and in one instance over $25,000,000 value was taken out in a month. Other mining companies were started, and all sunk shafts to various depths to intersect the rich vein at several points. In many cases millions of money were spent in sinking shafts to great depths in the belief that there was a still richer deposit beneath the Comstock lode. Nothing of great value was discovered, however, and in 1882 the deep level works were abandoned. The mines were all subject to flooding, but so long as the working was confined to shallow depths the drainage question caused little trouble. Large fortunes were spent in providing adequate drainage for the deeper workings, but in 1882 they were allowed to fill with water. The deposits found below the original lode were not nearly so rich as those between it and the surface. But the shallow workings were rapidly exhausted, and in the early nineties very little work was going on at all—the mines were worn out and deserted. Since then the business has been revived, the lower levels have been emptied of water, and to-day a quiet but profitable industry has replaced the frenzied period of twenty years ago. The Comstock still holds vast treasures, but they are to be secured to-day only by work; the day of sensational discoveries there is past.

An immense amount of money has recently been laid out by the various mining companies to acquire modern machinery and appliances. Careful attention must be given nowadays to the cost of production. These great mining properties were formerly operated by steam power; but even then, fuel was so scarce and costly that the milling was not done at the mines. The ore, as taken, was conveyed a distance of some 15 miles to the mills, which were situated on the Carson River, where water power was available. Some idea of the cost of power at the mines will be gathered from the fact that at that time a limited amount of water power was served out to some of the mines, and this power supply was brought along a flume 40 miles long. Nowadays electricity is the energy used. The supply of power to the whole of the mines is undertaken by an independent electrical company formed solely for the purpose, and able to supply power at a much lower cost than any single mine could possibly do for itself. This supply company has built a large generating station in Floriston, California, close alongside the Truckee River—a distance of about 30 miles from the Comstock mines. The primary force is obtained from the river, at a point about 2 miles above the power station. The river is here crossed with a dam, 142 feet long and 7 feet high, built of timber cribwork, filled in with rock and sheathed with 4-inch planks. The water passes through five headgates into a settling canal, 600 feet long and varying from 20 feet to 100 feet in width; from this it passes through a screen into the flume. The latter is about 8,600 feet long and is 10 feet wide by 6 feet 8 inches deep. The penstock is built of pine, braced with ¾-inch iron rods, and divided by a wooden bulkhead into two compartments. The pipe lines, of which there are two, are of peculiar construction. They are built up of redwood staves, bound round with steel bands, the end joints between the staves being made with steel tongues. This structure is common to the whole distance, with the exception of a short length at the lower end, just where the lines enter the power-generating works. They terminate in short lengths of steel piping, which are riveted direct to the steel plates of the turbine casings.

The power house is a corrugated iron structure, set on brick and concrete foundations, close to the river bank. It is about 90 feet long by over 30 feet wide. The main power generators comprise two horizontal water turbines, each capable of an output of 1,400 horse power, at a normal speed of 400 revolutions per minute, and working under a head of 85 feet. The turbines are regulated and governed on the principle which maintains an equal constant flow through the pipe lines. As the admission gate to the turbine is closed, a by-pass valve opens and allows the excess of water not required in the turbine to pass direct into the tail-race. This method of governing has many advantages, the most important of which is that close regulation is secured without imposing any strains on the pipe lines, the momentum of the water flow in them being maintained constant. No loss of water is occasioned by this form of regulation in the case under notice, since the excess of water would simply pass over the river dam if it were not diverted past the turbines into the tail-race. Each of the large turbines is direct connected through a flexible coupling to a Westinghouse three-phase alternator of a full rated capacity of 750 kilowatts, at a pressure of 500 volts. Two exciting sets are also installed, each direct coupled to a separate turbine, and sufficiently large to provide exciting current for both the main generators running together at full load. The output of each exciter is rated at 22½ kilowatts.

The switchboard consists of three white marble panels, two of which carry the switches, instruments, and regulating devices for the main alternators, while the other carries the apparatus for the control of the circuits of the two exciters. The 500-volt current of the main generators passes through the switches, instruments, and circuit breakers of the switchboards to three step-up transformers, by which the pressure is raised to 22,000 volts. These transformers are of the oil-insulated self-cooling type, built in accordance with the long-proved Westinghouse transformer designs; the primary and secondary windings being split up into several sections in the form of flat coils of many layers, but few turns per layer, and arranged alternately on the core. The windings of the core are completely submerged in heavy mineral oil, which serves as an excellent insulator as well as a cooling agent. The high pressure leads from the transformers are carried on glass insulators direct to a set of main circuit-breakers by which they can be coupled to either or both of the overhead transmission lines outside. The circuit-breakers are of the long-break type, supported on a skeleton framework of iron piping. Lightning arresters of the Wurtz non-arcing type are installed in connection with the high tension side of the system.

The three-phase transmission lines are in duplicate, the hard drawn copper wires of No. 4 section being carried overhead on wooden poles of redwood, spaced 130 feet apart, and of taper square section varying from 11 inches at the base to 7 inches at the top. The poles are 30 feet high. The earthenware insulators are carried on pins of eucalyptus wood treated with paraffin, and let into the cross arms at the top of the poles. The size of the transmission lines was calculated to produce not more than 10 per cent drop in the pressure of the supply over the whole transmission distance, with the maximum output flowing. The distance covered by the transmission lines is over 30 miles, and they terminate at a sub-station in Virginia City, where, after passing through high tension circuit breakers, the current is led to a set of reducing transformers of similar type to those of the power generating station, and the pressure is reduced to 2,200 volts. At this pressure the current is distributed to various mines in the neighborhood. With one exception, this current supply is further reduced at the mines to a pressure of about 450 volts, at which it is used for various power purposes. In all cases, alternate current induction motors are used, and these are extensively adopted for such particular purposes as the driving of air-compressors, pumps, drills, hoists, and grinding and concentrating mills. At the Consolidated California and Virginia mines there are several electric hoists in full operation, each of which is driven by a 200 horse power Westinghouse type "F" motor. One of these hoists raises 3,760 pounds of rock as one load from a depth of 2,500 feet at a speed of 1,250 feet per minute. The total weight thus raised is 13,440 pounds. The motor actually doing this work is a Westinghouse type "F" motor of a rated capacity of 200 horse power, receiving current at about 2,200 volts pressure, with a frequency of 60 periods per second, and running at a normal speed of 550 revolutions per minute. The Westinghouse type "F" motor consists of a fixed primary part, which is a hollow laminated iron cylinder, carrying windings in slots on its inner surface. The windings of the fixed part, or the stator, receive the driving current. The rotating part of the motor is simply a second laminated cylinder, running inside, and very close to the stator, having copper bar conductors fixed in the slots on its outer surface. By means of collecting rings and brushes connected with an external variable resistance, the circuit of the rotor is completed, and the speed of the motor can be adjusted over a wide range by simply altering the external resistance. In the case of the Westinghouse type "C" motor, which is also extensively used on this distributing system, the collecting rings, brushes, and external resistance are dispensed with, and the rotor is simply arranged with a series of short circuited electrical conductors, forming what is known as a "squirrel cage" winding. The speed of the type "C" motor is thus practically constant. Another application of these motors on the Comstock, of particular interest, is that for the ore working mills. The grinding and the concentrating plant are driven by six induction motors, the ore being brought to the mills from the Gould and Curry mines along an electric trolley railway. The present, and practically the only, drawback of an alternate supply lies in the fact that it cannot be economically or easily applied for the purposes of rail traction; but considering that the modern improvements in rotary converters and in motor generators are so very pronounced, it is, after all, of little consequence, so that wherever power is required underground, or in any other place where dust, dirt, moisture, and explosive or inflammable materials abound, and where attention to power machinery is necessarily imperfect and always of the crudest, the polyphase alternate current electricity will certainly be used if economy, safety, and convenience are to be secured in the highest degree. The railway bringing the raw material from the Comstock mines to the mills is fitted on the direct current overhead trolley system. The current for this purpose is produced by a Westinghouse motor generator set of a type well known in practice, consisting simply of a "C" motor direct coupled to a multi-polar direct current generator.

Much more could be written of the wonderful work of the engineer in this world famous mining region; how its water supply is brought along pipes from a natural lake high up in the mountains 25 miles away; how the water supply has been partially utilized in a most ingenious manner for pumping dry the once drowned and abandoned Comstock mines, and the exceptional success which has attended such ventures.

This article deals only very briefly with one branch of the engineers' art as applied there, but sufficient of the history of the Comstock lode and its modern development has been recalled and noted to support the already well-established opinion that the success of modern mining depends to a very considerable extent upon the intelligent application of electrical power.—Engineering.

CONTEMPORARY ELECTRICAL SCIENCE.*

EMPIRICAL FORMULÆ.—The method of least squares, now accepted as the best method for determining the constants of an empirical formula, becomes unwieldy when powers higher than the second are introduced. E. G. Brown points out that it practically prevents the analytical application of all sorts of formulæ which it might be easily possible to apply by other means. He develops a class of formulæ involving Taylor's series, which he calls "power expansion formulæ." First, he introduces a new variable, x, such that for the given experiments its range shall be as nearly as practicable from 0 to 1. Then, instead of single-power terms, he uses "standard" terms made up of sums of terms, and compounded of the factors, x, $(1-x)$, $(1-2x)$, $(1-4x)$, $(3-4x)$, and so on. The first of these factors is the negative of the parabola used by Callendar in platinum thermometry. Curves of experimental data should be traced as bands having twice the experimental error for their width. In the graphic process the first term is the initial value of the dependent variable as given by the graph; the second is the average rate of charge for the whole experimental range; the third is the average curvature for the whole scale expressed in terms of a parabola; the fourth is the difference in curvature of the first and second half of the range expressed as a cubic standard formula. Formulæ and curves are given for as many as nine terms.—E. G. Brown, Trans., New Zealand Inst., 34, 1902.

ELECTRIC CURRENTS IN PLANTS.—In Waller's experiment, a leaf is placed on a glass plate between zinc electrodes, and one half of it is illuminated, while the other half is covered with black paper. An electric current then passes from the illuminated portion to the dark portion, especially under the red rays which are absorbed by chlorophyl. Waller believes this current to be due to a direct photo-electric action of the light upon the leaf. C. Ries gives a number of reasons for believing that it is a photo-chemical current of a non-physiological nature. In the first place it is not necessary that the leaves be green to show the effect. Then, no current is indicated when the electrodes themselves are covered. The effect also depends upon the material of the electrodes. When copper or silver electrodes are substituted for the zinc electrodes the current is reversed, and it is greatly reduced by carefully cleaning the electrodes. The effect is practically the same when the electrodes are dipped into the juice of the leaves instead of being in contact with them. The author believes the phenomenon to be identical with the photo-chemical currents observed by Hankel, Schmidt, Luggin, Pellat and others, and to be mainly due to the sodium, potassium and calcium compounds contained in the plants. The effect is enhanced by chlorophyl, just as it is by a variety of other dies and pigments.—C. Ries, Physikal. Zeitschr., August 15, 1902.

ATMOSPHERIC ELECTRICITY.—W. Caspari has made some valuable observations of the dissipation of electricity at Brienz, on the Rothorn, and on Monte Rosa. Some of the observations are very characteristic of Föhn weather, with its strong precipitations alternating with clear periods of very limpid air. During those periods there is great ionization of the air and large prevalence of positive ions. Thus, on the Rothorn, on August 27, the coefficient of dissipation of positive electricity was 6.84, and of negative electricity 20.98. On the Col d'Olen, Monte Rosa, the coefficients were 4.69 and 8.56 respectively on a foggy day, and 18.86 and 17.11 respectively on a clear day. On Monte Rosa, between September 4 and September 8, there was a regular alternation between snowstorms and sunny weather, always marked by a similar change from prevalent negative and positive ions respectively. There is a close connection between ionization and mountain sickness. A bad place for mountain sickness was the Lyssjoch, altitude 4,000 meters, at the edge of a vast ice clett. The coefficients of positive and negative dissipation at that place were 18.16 and 51.44 respectively, probably the highest ever observed. The high ionization was probably due to the same cause as that which produces it in a cellar. An excess of free ions evidently acts as a poison.—W. Caspari, Physikal. Zeitschr., August 15, 1902.

GENERATION OF RÖNTGEN RAYS.—T. Tommasina formulates the following novel view of the formation of Röntgen rays: The electric flux starting from the anode follows the lines of electric force, forming its own conductors, which consist of polarized alignments of radiant matter, as is the case in the production of

* Compiled by E. E. Fournier d'Albe in the Electrician.

electric phantoms by conducting powders in liquid dielectrics. The flux being of an oscillating character gives rise to a periodical destruction of the contacts, and thus produces vibrations which become visible in the form of luminescence. The cathode is not the only source of cathode or X-rays, as these may also be generated at the walls of the tube, and generally at any point where the anode flux is reflected. It is not necessary, as alleged by Semenov, that the anticathode be insulated. Cathode rays can be produced in a conical tube in which an electrode is placed at the top of the cone, and another in a side tube, by joining the former electrode to the positive pole of an induction coil through a water resistance, and leaving the other electrode and the other pole insulated. This would apparently mean that the impact of positive ions is sufficient to elicit negative ions and produce Röntgen rays. The production of the latter, which require a high velocity of impact, could hardly be due to the impact of slow positive ions.—T. Tommasina, Comptes Rendus, August 11, 1902.

CONDUCTION IN A NERNST LAMP.—The accepted theory of the burning of a Nernst lamp is that it is a process of electrolytic conduction. The difficulty then confronting us is that such a lamp will burn hundreds of hours and consume a direct current which should theoretically electrolyze it in about five minutes. E. Bose imagines the process to be as follows: In the oxides which make up the conductor, the velocity of migration of the cation is probably very much smaller than that of the anion. Hence the chief part in the current conduction is probably played by oxygen ions, whereas the metallic ions in a stationary state undergo no displacement. The oxygen evolved at the anode diffuses back to the cathode in the interior of the rods, and there oxidizes the metal again. The oxygen of the air, which surrounds the rod and also penetrates into it encourages the process, and leads to the well-known increase of durability of the lamp as against its behavior in a vacuum. This is substantially Nernst's "Reststrom" theory, and the author confirms it by some interesting observations. One of them is that in a vacuum the rod gradually assumes a darker hue and a metallic aspect, which disappears on exposure of air. The vacuum round the glowing rod could never be driven so far as it could when the rod was cold.—E. Bose, Ann. der Physik, No. 9, 1902.

HOLLOW CONDUCTORS IN WAVE TELEGRAPHY.—A. Turpain has studied the effect of employing hollow conductors, both as regards protection from penetrating waves and concentration of waves inside them. An exciter could be inclosed in a box lined with tin, about 25 centimeters square. A receiver, comprising a coherer, a relay, and a bell and battery could be inclosed in a similar box. Each box had a circular hole 14 millimeters in diameter, through which a conductor could be introduced consisting of a bare wire, a tube, or a leaded cable 10 meters long. When the transmitter and receiver are both completely inclosed, no action between them is possible. Also, when the holes are open, and are joined across by a metallic tube, no action is noticed. But when the tube enters the boxes without touching the tin, or when the boxes are removed, a decided response is seen. In these cases the tube appears to concentrate the waves upon the receiver. The action is still better when a cable with metallic covering is substituted for the tube. In this case the core of the cable joins the two apparatus, and the leaden wrapping serves to concentrate the waves. The concentrating action is not impaired by peeling off a short length of the leaden wrapping, so long as there is no metallic connection between the core and the portion of the wrapping attached to the receiving box. If the other portion of the wrapping is connected with the core, it makes no difference. These observations give valuable hints with regard to Hertzian wire-telegraphy. The metallic wrappings of every submarine or subterranean cable should be continued right up to the transmitter and receiver. Each of the latter should be contained in a hollow conductor connected with the metallic wrapping. Under these conditions a powerful concentration of the electric waves is obtained, which would be impossible if the waves passed from the core to the metallic wrapping of the cable at the point where the cable commences. Beyond that point the waves could be dissipated in the ground or in water. The experiments may be utilized also for wave telegraphy. The author proposes that both transmitter and receiver should be inclosed, and joined to the air wire by means of a cable with metallic wrapping. The experiments show that no inconvenience is caused by connecting the wrapping of the transmitter cable to the air wire itself. As regards the receiver, a connection between the cable wrapping and the air wire would constitute a very effective and convenient protection of the receiver against waves emitted from the station. This connection could be interrupted when receiving.—A. Turpain, Comptes Rendus, September 8, 1902.

SPECTRA OF DISCHARGES THROUGH LIQUIDS.—In an endeavor to obtain an easy means of producing intense band spectra, and also to shed some light on their origin, P. Konen has investigated the spectra shown by the electric arc, the brush discharge, and the spark discharge as produced in liquids such as distilled water, salt solutions, ammonia, acids, turpentine, aniline, glycerine, carbon bisulphide and benzol. It was found that the nature of the liquid has little influence upon the arc spectrum unless carbon terminals are used. Metallic electrodes may be plunged into a solution containing several per cent of lithium without giving the lithium lines in the arc spectrum. With carbon electrodes, the cyanogen bands are absent in water, salt solutions, alcohol, turpentine, glycerine and CCl_4. But small traces of air suffice to bring out the band 3,883. This confirms the supposition that the cyanogen spectrum is due to a nitrogen compound of carbon. The "Swan" spectrum—that is, the carbon band spectrum possessing edges at 4,382, 4,738, 5,164, 5,633 and 6,187—could not be made to disappear even by the most careful elimination of oxygen. But the author does not consider this conclusive as against the carbon monoxide theory of the Swan spectrum. The brush discharge shows a somewhat similar behavior to the arc. The spark spectrum is continuous and overlaid with lines due to the electrodes and the liquid.—P. Konen, Physikal. Zeitschr., September 1, 1902.

METHODS OF FISHING IN HAWAII.

OWING to the fact that he has always been largely dependent upon the sea for a goodly portion of his daily food, the Hawaiian fisherman has developed into a remarkably ingenious and successful one. Many of his methods are curious, and some of them are unique, and in the case of certain forms of apparatus could be adopted by the fishermen in the States with considerable resulting profit.

"Lau Kapalili" (trembling leaves) is a method of bag net fishing which was at one time popular in the islands. It was called "The Fishing of Kings," as they only could command a sufficient number of canoes, men and "la," or rope. The late Kamehameha V, whose favorite residence was at Waikiki, on Oahu, frequently ordered it. A large bag net, called a "papa," and ropes 400 fathoms in length, with the broad long leaves of the "ki" plant attached, would be loaded on a large double canoe and taken out several miles from shore, attended by a fleet of from sixty to one hundred single canoes. On reaching the proper distance, which must be opposite the final drawing place, the end of one rope is joined to that of the other, and two canoes, manned by eight or ten strong natives, take hold of different ends of the rope and start in opposite directions and parallel to the shore. The rest of the canoes divide into two companies and follow the canoes, stationing themselves at certain distances along the rope, helping to pull it. In the meantime the double canoe with the net remains stationary in the center.

As soon as the rope is all paid out the two leading canoes curve in to form a semi-circle, at the same time working toward the shore. As soon as the semi-circle has been completed and the shore reached, the men leap out, and, taking hold of the line, pull on it, at the same time going toward each other, which has the effect of narrowing the semi-circle, while most of the canoes keep backing toward the double canoe, which keeps in the center. As soon as they have reached a suitable place, which is always a clean, sandy one, a few rods from shore, the ropes are untied and attached to each side of the "papa" net. The men, women and children now gather closely on the rope, especially near to the net, and make a great disturbance with their feet, which drives all the fish into the net. "Lau" and net are finally drawn ashore and the net is emptied. This fishing can only be carried on on a clear, bright, sunny day, so that the shadows cast by the leaves can be seen and serve to frighten the fish inland.

In fishing for "malolo," the flying fish, twenty to forty canoes are frequently employed. When a school has been sighted the bag net is dropped in a favorable position, while the main body of the canoes are surrounding the school. When this has been accomplished the canoes are all paddled in quickly toward the mouth of the net, the occupants splashing the water, thus driving the fish before them. The "malolo" are always found swimming near the surface, and as they will not dive to any depth they can be driven in any direction desired.

In fishing for shrimp in the mountain streams, a small basket, shaped like the coal scuttle bonnets in vogue some years ago, and woven from the roots of a certain plant, is used. This fishing is done by women. The native woman, outside of the towns, is never heavily burdened with clothing, even when dressed in her best, the "holoku," a flowing mother hubbard, being the principal garment. When shrimping she either wears an old "holoku," gathered up to the waist, or else strips to nature's garment. Holding the basket in one hand and a short stick in the other, and moving in a crouching position through the water, she drives the shrimp from under the rocks, etc., to a suitable spot, which is always some place where the grass, ferns, or branches of trees droop over in the water. The shrimp take refuge in or under these, and the fisherwoman, placing her basket under the leaves, lifts them out of the water, when the shrimp drop off into the basket, whence they are removed to a gourd with a small mouth, which the woman has been dragging behind her in the water by a string tied to her waist.

The largest kind of basket used in the regular ocean fishing is called the "ie kala." This is made round, rather flat, from four to five feet in diameter by two and one-half to three in depth, and about one and one-half feet across the mouth. A small cylinder, or cone, of wicker is attached by the large end to the mouth and turned inward toward the bottom of the basket. This cone or cylinder is small at the free end, just large enough for the fish to get in. Immediately below the end of this cone, on the bottom of the basket, is placed the bait, properly secured, which is generally ripe bread fruit, cooked pumpkins, half roasted sweet potatoes or "papaias." The fishermen generally feed the fish at a given place for a week or more before taking any, using for this purpose a large basket of the same kind, without the inverted cylinder, and wider in the mouth, to allow the fish free ingress and egress. After a week or two of feeding they become very fat and fine flavored, and also tame, and basketfuls of fish can be drawn up in the taking basket without in the least disturbing those which are still greedily feeding in the feeding baskets.

Decoy fishing is sometimes practised. In fishing for the "uhu," a highly prized kind of rock fish, of two species, the red and the green, a decoy fish, which must have previously been caught with the "uluulu," or hook and line, is then dropped, with a string attached, in a place where fish of that kind are known to frequent, and gently moved back and forth, which the natives call "hoohaehae," "teasing the fish." A square net, which has been slightly gathered on the ropes and attached at the four corners to slender strong sticks tied together at the middle in such a way that they will cross each other at this point, and can be closed together when desired, is used. When the sticks are crossed they spread the net open in the form of a shallow bag. A string is tied to the crossing of the two sticks, and the net is lowered just below the decoy fish. The "uhu" are attracted by the strange antics of the decoy and swim close to observe it. The net is quickly pulled up, the sticks bending over, which elongates the bag, thus reducing the opening or mouth. By a peculiar twitch and pull on the string the sticks can be made to swing around and lie parallel, thus effectually closing the bag. As it is necessary to be able to see the bottom when fishing this way the fishermen always carry for this kind of fishing candlenut or cocoanut meat, which they chew and spit overboard from time to time to smooth the sea, so that they can observe the bottom. This same method is followed for other species of fishes, the only difference being that a decoy of the species to be caught is used. The "uhu" is generally eaten raw by the natives, who are fond of it.

Another kind of decoy fishing is with the "lau melomelo," the decoy used being a billet of Kauwila wood, one of the hardest in the islands. This is something like a policeman's club, being rounded at the ends, with one end smaller than the other, this latter having a little ringed knob to tie a string to. It varies in length from thirteen inches to three feet. After the proper incantations have been performed over it by a sorcerer or "kahuna," it is charred slightly over a regulation fire. Having once attained its power, great care must be taken by the fisherman that it does not lose it. If a woman should step over it, or enter the canoe in which it is placed, the stick would lose its power. Candlenut and cocoanut meat in equal quantities are baked together, and are then pounded up and tied in a wrapping of cocoanut fiber. On arriving at the fishing ground the stick is covered with the oily juice of the baked preparation, and allowed to hang suspended a few feet from the bottom. The scent of the baked nut seems to have an attraction for certain species of fish, which soon surround the stick and smell or nibble at it. In a few minutes a small bag net is dropped overboard and maneuvered until its mouth is toward the suspended stick. The latter is then moved gently into the bag, the fish following it. Two of the natives dive down and, carefully approaching the net, quickly close its mouth and give the signal to those in the canoe to haul up. Should the fishing prove poor, it is ascribed to the imperfect performance of the incantations.

The native is a great lover of the octopus, or "Hee," as they call it, and has a variety of methods of capturing it, one of the most interesting of which is with the cowry shell. One or more of these shells are attached to a string, with an oblong pebble on the face of the shell. A hole is pierced in one end of the back of one of the shells, through which the line is passed, and, having been fastened, is allowed to project a few inches below, and a hook whose point stands almost perpendicular to the shaft or shank is then fastened to the end of the line. Only the finest kind of Mauritiana, or tiger cowries, are employed for this purpose, as the octopus will not rise to a large spotted or ugly one. The spots on the back must be very small and red, breaking through a reddish brown ground. Cowries, with suitable spots, but objectionable otherwise, are slightly steamed over a fire of sugar cane husks, which gives them the desired hue.

On arriving at the fishing ground the fisherman chews and spits on the water a mouthful of candlenut meat, which renders the water glassy and clear, or else uses a water glass. This latter is a square oblong box, with a pane of glass at one end. By putting the glass-inclosed end on the water, and inserting his head at the open end, the fisherman can see the bottom distinctly, even should the surface be covered with ripples. The fisherman then drops the shell with hook and line into the water, and gently swings it over a place likely to be inhabited by an octopus. The octopus is a voracious animal, and the moment the cowry is seen one arm is shot out and the shell clasped; if of the attractive kind, one arm after the other comes out, and finally the whole body is withdrawn from the hole and attaches itself to the cowry, which it closely hugs, curling itself all around it, and seeming oblivious of anything but the pleasure of hugging its "lover." It remains quiet while being rapidly drawn up through the water, till, just as its head is exposed above the surface, it raises it, when the fisherman pulls the string so as to bring its head against the edge of the canoe, and it is killed by a blow from a club, which is struck between the eyes. It is necessary that this should be done rapidly, before the animal has had time to become alarmed and let go the cowry, when, should the arms be a fathom in length, which is sometimes the case, it becomes a dangerous antagonist, and there is danger of the fisherman being squeezed to death or dragged into the water and drowned. Having eight tentacles, or arms, an octopus of such a size could well manage several persons, as the cutting off of one or more of its arms does not affect the rest in the least.

The natives are expert with the spear in fishing, and use it with equal facility, either above or below the surface of the water. In fishing below the surface the native dives to a favorable spot among the rocks, and, bracing himself in a half-crouching position, waits for the fish to come along. He only notices fish in two positions, those passing before and parallel to him and those coming straight toward him. He aims a little in advance of the fish, as by the time it is struck its motion has carried it so far forward that it will be hit on the gills or middle of the body, and thus secured, but if the spear were aimed at the body, it would be apt to hit the tail, or entirely miss the fish. The spear is generally sent with such force that it goes right through the fish, thus bringing the latter up to the upper part of the spear, where it remains while the fisherman strikes rapidly at other fish in succession should they come in single file, as they usually do.

A popular method of capture in certain sections is that of using stupefying plants. The "ahuhu," a poisonous weed, is generally used for this purpose. It is gathered and pounded up with sand, the latter being added so as to make the preparation heavy enough to sink in water. All over the reefs, close to the shore, are numerous caves, holes, etc., which form the habitat of many species. The fishermen take along a small seine and a quantity of this poisonous mixture.

Arriving at a suitable spot the seine is put into the water and run completely around an isolated rock, or in front of a cluster. This is to prevent the fish from escaping. The fishermen then place some of the mixture into a small bag, and, diving down to the bottom, inside of the net, flirt some of it into the holes. In about ten or fifteen minutes the fish seem to become stupefied, and rise to the surface, and are dipped into the canoe by means of small scoop nets. The fish soon recover from the effects of the poison if allowed to remain in water. This manner of fishing is contrary to law.

The natives are perfectly at home in the water, and can remain below the surface two and even three minutes at a time, and as a result a considerable part of their fishing is done by means of diving. Clusters of rocks are numerous in the water a short distance off shore, and the natives often run a gill net completely around such a cluster, and then, diving down to the bottom, between the net and the rocks, poke around in the crevices with their hands or a stick. The fish are scared out, and as they dart wildly in every direction they are meshed in the net.

The fisherman frequently makes a net by attaching a small net bag to a slight supple pole. When not in use this pole is bent to form three-fourths of a circle. When in operation the fisherman draws the two ends together; crosses them, and holds them tight in his hand. A small stick, with pieces of rag or "lau hala" leaves attached to the end, is also used. When fishing the native paddles his canoe along until it is immediately over a rocky bottom, where holes are numerous, takes the bag in his left hand, the small stick in his right hand, and dives to the bottom. He pushes the bag close up to one of the holes, and with the stick brushes the fish from the holes into the bag. He then allows the two ends of the stick to slide down in his hand until the ends lie parallel, and this nearly closes the mouth of the bag, thus preventing the escape of the fish.

In fishing for "ula" (crawfish; locally called lobster), the fisherman, attired only in a "malo," or loin cloth, attaches a small bag to this, and, wrapping his right hand with a long linen or cotton cloth, dives to the bottom, and, feeling around in the holes pulls out the "ula," which are hiding there, and places them in his bag. As soon as he feels the need of more air, he ascends to the surface and empties out his bag. He wraps up his hand so that the animal cannot bite him, which it would be very apt to do otherwise.—N. Y. Tribune.

THE RESPIRATION-CALORIMETER AND ITS USE.

Four years ago the United States Department of Agriculture determined to carry out an investigation into the fundamental principles of the nutrition of domestic animals. It was desired to obtain more accurate information than we now have regarding the fundamental laws of animal nutrition, the use of food in the body, the nutritive values of food materials, and the ways of fitting our food to the demands of health and work. After a careful study of all that Europe could offer in the way of special apparatus which might be of assistance in carrying out this investigation, it was decided than an American apparatus devised by Professors Atwater and Rosa of Wesleyan University, was far superior for the purpose to any foreign machine. Accordingly Frederick Hart, of Poughkeepsie, N. Y., was intrusted with the building of a machine, the purpose of which was to gather data whereby it would be possible to study the application of the laws of the conservation of matter and the conservation of energy in the animal organism. Fully two years of work were required to carry out the plans.

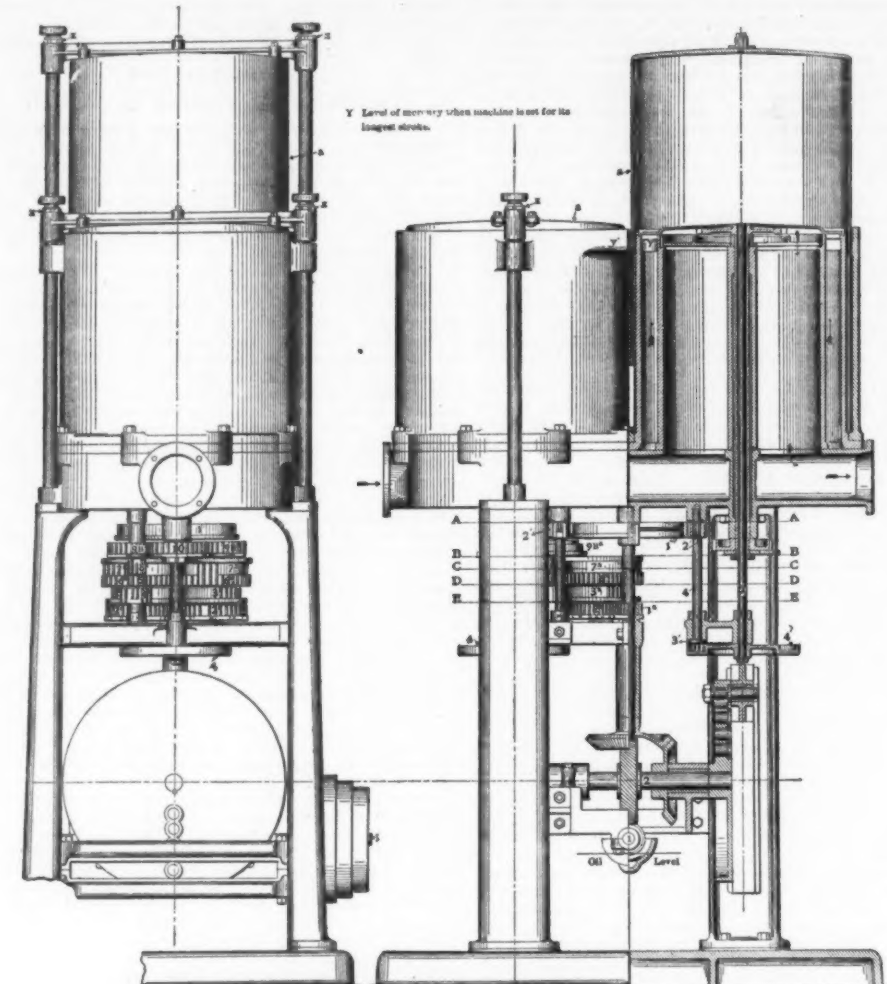


FIG. 1 FIG. 2

THE RESPIRATION-CALORIMETER FROM THE REAR AND FROM THE SIDE.

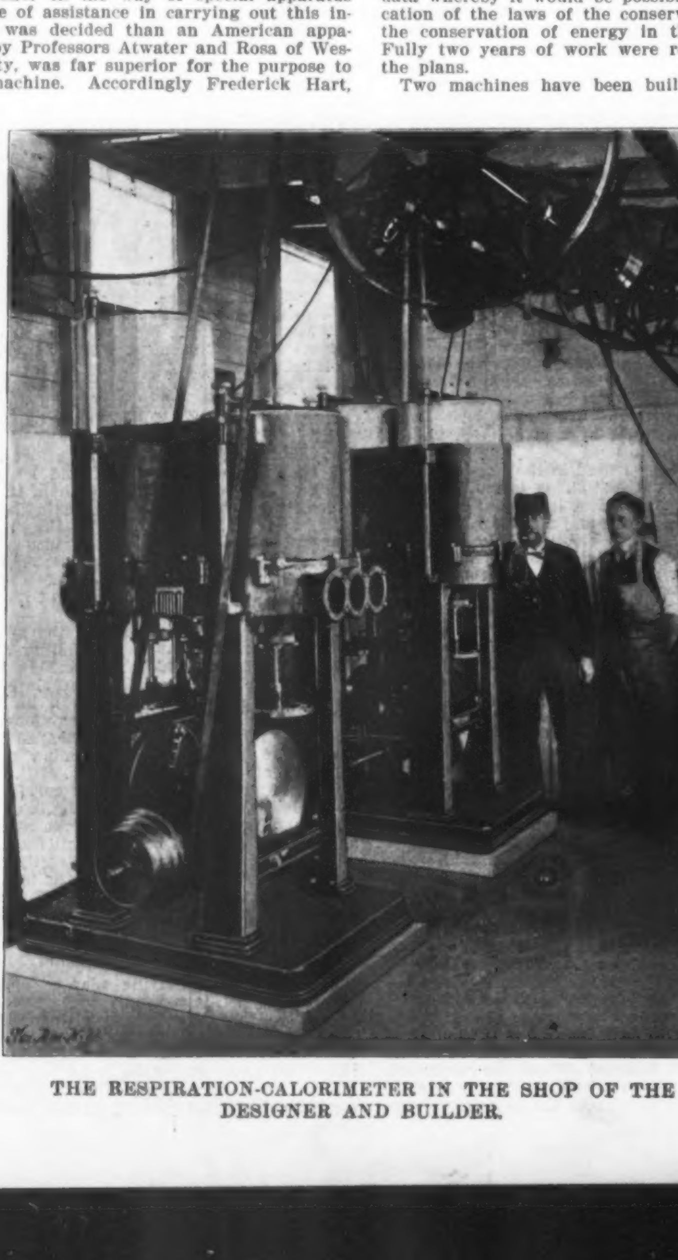
Two machines have been built for American use. One at Middletown, Wesleyan University, used for experiments upon man, and one at the State College of Pennsylvania, for experiments upon animals. The machines are the only ones of their kind in existence.

The Middletown machine is so constructed that within its capacious compartment a man or an animal can be confined continuously for twelve days. While the occupant is thus confined all food that is supplied to him is measured and weighed, as well as air and hay. All that comes from the chamber is also measured and weighed.

The apparatus is called the respiration-calorimeter, a name suggested by the fact that it is essentially a respiration apparatus with appliances for calorimetric measurements. The calorimeter is essentially a water calorimeter; that is to say, the heat evolved in the chamber is measured by a current of water.

The apparatus includes first of all a room or chamber in which the subject remains during the experiment. The chamber is furnished with a folding chair and a table for the man's use during the day and a folding bed on which he sleeps at night. When the experiments require muscular work, gymnastic apparatus, such as a stationary bicycle, especially arranged for measuring the work done, is also introduced. Light enters through a window, so that the occupant can see to read and write. Ventilation is provided by a current of fresh air maintained by a pump especially devised for the purpose. This pump not only keeps up a constant current of air, but also measures its volume and affords samples regularly and accurately for analysis. The air is made to enter the chamber at the same temperature as when it goes out, so that the quantities of heat brought in and carried out by the ventilating current are the same. Certain devices prevent the passage of heat through the walls of the apparatus. The heat given off from the body is carried away by a current of cold water which passes through a series of pipes inside the chamber. The house is warmed in winter by a current of water which is heated in the basement and passes through two pipes into the different rooms. The heat thus radiated from the water into the room keeps the air of the latter at the desired temperature. In like manner the house might be cooled in summer by a current of cold water, in which case the radiators would become absorbers. The heat would be taken up from the air of the room by the cold water and carried away. Exactly this is done by the absorbers inside the chamber of the respiration-calorimeter. By regulating the temperature of this water current as it enters, and also its rate of flow, it is possible to carry away the heat just as it is generated, and thus maintain a constant temperature inside the chamber. The amount of the outgoing water and its temperature are measured, thus determining the heat carried away.

The object of the experiment is to study the food as a source of energy, or in other words, as the fuel of the body. Food is burned in the body somewhat as coal is burned in a locomotive, and gives much the same final results, namely, heat and motion. A bushel of corn or a bale of hay burned in a furnace gives off a certain definite amount of energy as heat. If we feed corn or hay to an animal we supply the animal with just that total amount of energy. One of the aims of the experiments undertaken with the respira-



THE RESPIRATION-CALORIMETER IN THE SHOP OF THE DESIGNER AND BUILDER.

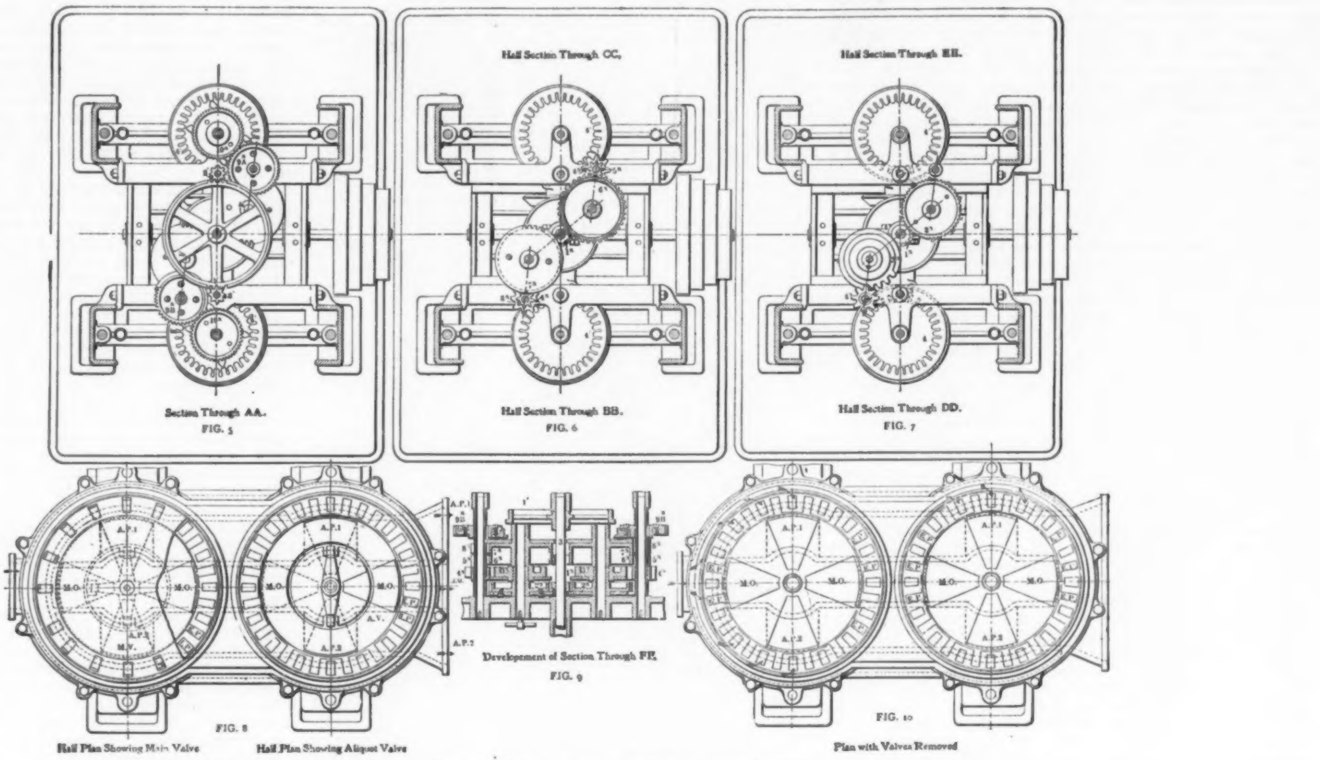
tion-calorimeter is to find out what proportion of its energy can be utilized by an animal to produce heat or make work, and how much is simply used up in heating the surrounding air. A comparison of corn and hay, for example, in this respect will show which one contains the greater source of energy in available form. Similarly a comparison may be made of the ability of different animals to utilize the energy of the same food, or of the influence of various external conditions, such as temperature, water supply, light, etc.

The comparisons are made much as we might make them with a locomotive. Knowing the energy contained in coal, an analysis of the waste products including the gases from the stack, and the determination of the heat given off, would furnish the elements necessary for the comparison. In the case of the animal, the visible excreta can be readily collected and analyzed by proper appliances. The flue gases are represented by the breath of the animal, the gases of which are carried out of the chamber in the current of air.

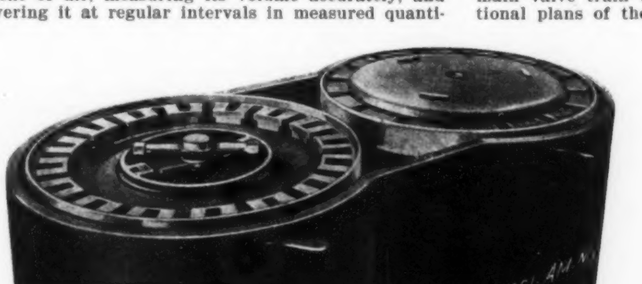
The peculiar difficulty which confronted the designer of the apparatus was the maintenance of this current of air, measuring its volume accurately, and delivering it at regular intervals in measured quantities for analysis. That in itself was difficult enough. But it was furthermore necessary to handle the air so as not to increase its temperature or to bring it in contact with substances which would cause it to absorb things that might vitiate the subsequent chemical analysis. It was desirable to be able to increase or decrease the volume delivered per revolution of the machine, to vary the number of revolutions per minute and to vary the proportion of aliquot parts, i. e., 0.01, 0.02, and 0.04. It was likewise desirable to build the machine so that it might be operated for thirty or sixty days continuously without a stop for any purpose whatever.

We have already stated that Mr. Hart built two of these machines, one for the Pennsylvania State College and the other for Wesleyan University, Middletown. Others have been constructed for the German Agricultural Station at Bonn and the Hungarian Agricultural Station at Buda-Pesth. Our illustrations picture the machines built for shipment abroad. Of the diagrams we present, Fig. 1 is a side view of the machine, half in section; Fig. 2 is an end elevation; Fig. 3 is the aliquoting train of gears; Fig. 4 is the main valve train of gears; Figs. 5, 6 and 7 are sectional plans of the valve gear at different points, as indicated; Fig. 8 is a plan of the valve and ports; Fig. 9 is a sectional view of the valve gear, and Fig. 10 is also a plan of the valves and ports.

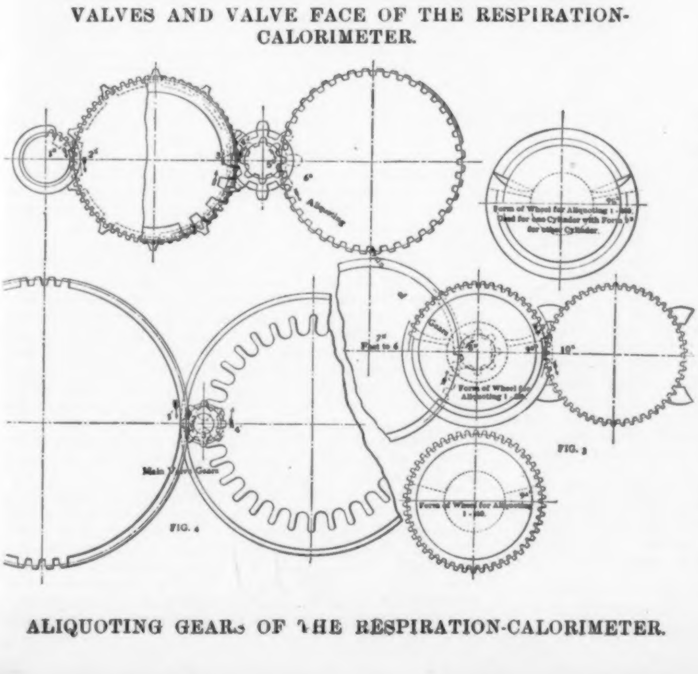
Motion is imparted to the machine by the cone pulley shown in Fig. 2 on the right of the machine. This cone is keyed onto shaft 1 on which is a spiral gear which drives the crank shaft 2. This crank shaft has at each end a disk crank with a crank pin that can be shifted into different holes so as to give different lengths of stroke. On shaft 2 is a pair of miter gears for driving shaft 3. This shaft makes one revolution in unison with shaft 2, and from this shaft is driven a train of gears which moves the main valve, marked *MV*, and the aliquoting valve marked *AV*, Fig. 8. The main valve is driven through gear 1_1, which by reference to Fig. 4 will be seen to have two lots of four teeth each, at opposite sides of the gear. This gears into 2' in such a way that for every revolution of the machine the gear 2' makes two half turns, that is, a half turn at the instant that the crank is at the top and the bottom of the stroke. On the other end of the shaft 4 on which pinion 2' is fastened, is a two-toothed pinion 3', which for every half turn advances gear 4' one tooth. Gear 4' is fastened to the end of shaft 5, Fig. 2, to the top end of which is fastened a crosshead, the main valve having



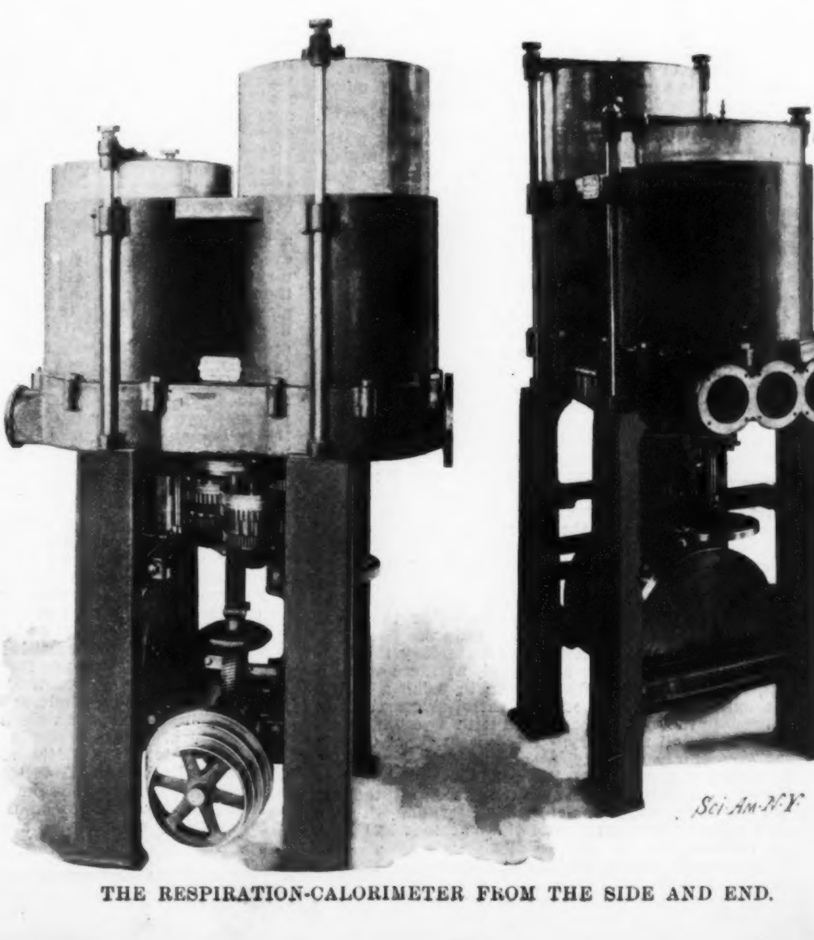
DIAGRAMS OF THE GEARS AND VALVES OF THE RESPIRATION-CALORIMETER.



VALVES AND VALVE FACE OF THE RESPIRATION-CALORIMETER.



ALIQUOTING GEARS OF THE RESPIRATION-CALORIMETER.



THE RESPIRATION-CALORIMETER FROM THE SIDE AND END.

two pairs of lugs which fit down over the end of the crosshead, so that this shaft is free to move vertically to a limited extent without in any way displacing the main valve. Wheel 4 has just as many teeth as there are induction and eduction ports; the valve has just half as many ports (Fig. 8), so that as it is moving round on the top of the valve seat it opens alternately to the air receiver the induction ports marked *IP* or the eduction ports marked *EP*.

The aliquoting mechanism is driven from shaft 3 by the pinion 1*a* (see Figs. 9 and 3) which is also an intermittent gear like 1', only in this case it has only four teeth and moves wheel 2*a* one-tenth of a revolution for every revolution of the machine. Attached to the wheel 2*a* is wheel 3*a*, which has four teeth. This moves pinion 4*a* one-fourth of a turn for two consecutive turns of the machine, and then dwells for eight consecutive turns. Pinion 5*a* is attached to 4*a*, and for every one-fourth of a turn of 5*a* spur wheel 6*a* moves one-twentieth of a turn, so that wheel 6*a* moves one-twentieth for two consecutive turns of the machine, and dwells for 98 consecutive turns of the machine. Wheel 7*a* is fixed to 6*a*, and is an intermittent gear having only four teeth which occupy just one-tenth of its pitch diameter, and since 6*a* and 7*a* both move one-twentieth of a turn to one revolution of the machine, pinion 8*a* will move one-fourth of a turn. 9*aB* which is fixed to 8*a* will therefore make one-fourth of a turn for two consecutive revolutions of the machine, and dwell 98 revolutions. Wheel 9*aB* gears into 10*a*, which is of the same pitch diameter and is fastened to the end of the tubular shaft on which is mounted the aliquoting valve. 9*aB* is an intermittent gear and operates upon 10*a* only during one-fourth of a revolution, consequently 10*a* makes one-half revolution for each two consecutive revolutions of the machine, and dwells 198 revolutions. The time occupied in making this movement, therefore, is only during one-fourth of the revolution, and the movement occurs during the upstroke of the air receiver in conjunction with which this valve operates. Of course the movements of the main valve are so timed that the induction ports are opened and the eduction ports closed during this upstroke. Now on referring to Figs. 8 and 10 it will be seen that the aliquoting valve *AV* has only one opening through it, but that its seat has four openings, two of which marked *MO* communicate with the same outlet pipe, which we term the main outlet. The port marked *AP*1 communicates with aliquoting port 1, and *AP*2 communicates with aliquoting port 2. Now if the aliquoting valve is as shown in Fig. 8, and the gearing is in such a position as to move the valve, then the port in the aliquoting valve will travel from the port marked *MO* to the port marked *AP*1, and it will commence to do this when the crank has traveled from the dead center one-eighth of a revolution, or thereabout, and stops before it has reached the other dead center by one-eighth; then the air receiver will make a downstroke and discharge through *AP*1. During its next ascent the valve will move another one-fourth turn to the main outlet, and will remain there during 198 revolutions, when it will complete its revolution. The valve of the other air receiver can, of course, either work in unison with these valves, or be made to move exactly in the middle of the dwell. By removing the keeper part of gear 9*aB* and substituting the other part of the gear, making it a continuous gear like 9*aA*, the aliquoting valve will then make two consecutive movements, and dwell 98, so taking a 1 per cent aliquot part. Now if on the gears attached to one air receiver we remove all the teeth from 9*aB*, and substitute a continuous keeper, making it like 9*aC*, this will prevent the aliquoting valve from moving, and so prevent the aliquoting charge from being taken from the air receiver, thus reducing the volume of the aliquoting part to 0.0025.

The object of having two aliquoting ports is to give more time for making an analysis. The aliquoting ports 1 and 2 discharge into different analytic chambers, so that two operators can be working on the analysis at the same time. This, however, added quite a little to the difficulty of accomplishing what was desired.

The annular space in which the air receivers work up and down is filled with mercury, and one annular space communicates with the other by a large passageway at the bottom, and also at the top, so that as the receivers rise and fall the level of the mercury does not change.

In altering the stroke of the machine, the nuts marked *X*, which are made of different lengths, are also changed, so that by removing the top nut, which screws directly on the side bars, and removing nut *X* from the yoke, and replacing by one which corresponds with the amount of reduction of the stroke of the machine, caused by changing the position of the crank pin, and then coupling up again, the air receiver will then work always at the bottom of the stroke, that is, the shortening of the stroke has been from the top end and not from the bottom end, so that the air receivers are emptied every time no matter what the stroke. The passage of the air through the machine starts at the ports shown by the arrow in Fig. 10, passing round the outside of the machine and up to either of the air receivers through the ports marked *IP*; then upon the air receiver descending it goes out through the ports marked *EP* and into the space between the main valve and the aliquoting valve, and then down through the main port as indicated by the arrow, or down through one of the aliquoting ports and so out of the machine to either the main refrigerator or to the analytical chambers.

By sealing the air receivers with mercury the temperature of the air was not raised, as there was no friction, as there would have been in using a piston in a cylinder, neither were the chemical constituents changed as they would have been with a piston on account of the oil necessary. The measuring of the air was exceedingly accurate, as at the highest speed of the pump the difference between the atmospherical pressure on the outside and the inside of the air receiver was so small as not to be discernible with the most delicate instrument, and the machines had been run continuously for considerably over a week.—Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

RECENT PROGRESS IN ASTRONOMY.*

By J. K. REES, Columbia University.

THE opening years of the twentieth century are full of remarkable and most striking evidences of man's power over the forces of nature, and yet with this feeling of might there comes to the thoughtful student, and perhaps especially to the astronomer, a deep reverential feeling of man's utter insignificance, and the littleness of his knowledge, in comparison with what is necessary for the complete mastery of the problems that present themselves.

Heat, light and electricity are the forces which have been so grandly made use of by the scientific man and the practical engineer. It is enough for me to refer only to the stupendous developments of the machinery making use of steam for locomotion on land and sea; to the great labor-saving devices used in the manufacture of steel and other needed things.

Still more marvelous are the applications of electricity; and the promises for the near future are most startling. I do not desire to develop these lines of thought, because I am aware that the young men of this institution, and especially those of the graduating class, have minds well stored with apt illustrations; and their imaginations can rapidly construct dreams of the future, based upon their own intimate knowledge of what has been done, and what is just on the point of being accomplished, by the application of heat and electricity.

This morning in my short address I wish to call your attention to some of the triumphs lately achieved by the use of light. And inasmuch as my work is mainly astronomical you will, I know, permit me to dwell entirely on the matter of celestial photography.

The United States has many reasons to be proud of what her astronomers have done both in the improvement of photographic telescopes, and in the results of photographic research; but the whole world has been active in applying this comparatively new instrument. The promise of future developments is indeed very gratifying. Every one is deeply interested in the study of the make-up of the solar and lunar surfaces. To-day photographic telescopes supply us with most of our accurate knowledge of details.

Exposures on the sun are made, lasting one to several thousandths of a second of time, which on development bring out the texture of the photosphere, the details of spots and spot groups, and the faculæ. These plates are taken with great regularity at several observatories in the world, and are studied at leisure by a trained force of observers. Rutherfurd in New York city from 1870 to 1874 took many solar photographs the study of which has given us much valuable information. And since his time Greenwich, Paris, Meudon, Mt. Hamilton (Lick), Harvard, Yerkes and other observatories have taken thousands of plates. Many of my audience have seen such pictures thrown on a screen by the aid of a lantern, and thus have been able to study sun spots, photosphere and faculæ in a most instructive and accurate way.

The earth's only visible satellite has always stirred the interest of the astronomer. Schmidt, of Athens, Beer and Mädler, of Germany, and many others have spent years of labor in making topographical drawings of the moon, and they published very fine maps. Thirty years ago Draper and Rutherfurd showed the world what excellent photographs could be taken with wet plates, and from that time many of the great observatories have collected hundreds of photographs of the moon on the very sensitive dry plates of recent years. We have now exquisite plates to study and measure. Lately the French government has published exact heliogravure copies and enlargements of the lunar photographs taken by Loewy and Puiseaux.

In this connection it is proper to call attention to the difference between an object glass for seeing and one for photography. The yellow rays affect the eyes most readily and so the lenses must be ground to bring those rays to a focus. But the blue and the violet rays affect most the photographic film. So that with a telescope arranged for seeing, the photographs obtained, in most cases, are hazy and indistinct. Rutherfurd, therefore, placed outside of his seeing object glass a lens of flint glass, so arranged as to bring the blue rays to a focus. It was with such a lens that he obtained his fine plates of the sun, moon and stars.

To-day this same system of lenses is mainly used, or a system involving the same principle. Lately, however, there has been discovered at the Yerkes Observatory a new method which gives great promise. When the University of Chicago bought the forty-inch object glass, they were unable to raise the money to buy the needed extra lens, which would enable them to photograph well the moon and other heavenly bodies. Fortunately, this was so, for it resulted in experiments by Mr. Ritchey which demonstrated the fine results to be obtained by a screen. This screen of colored glass was put in front of the sensitive plate, and allowed only the yellow and red rays to pass through the plate—it kept out the blue and violet rays—and, therefore, only those rays reached the sensitive plate which were accurately focused by the object glass. The result was some splendid photographs of the moon and its details, as fine as anything so far obtained. This discovery of the use of a proper screen gives the promise of converting any good seeing refracting telescope into a fine photographic instrument with very small expense.

The reflecting mirror, when properly shaped, brings to one focus all the rays of light; as well those rays which affect the eyes best as those which produce the desired result on the sensitive film. This fact has brought into increasing use the reflectors of large and small diameters. Modern methods of producing and mounting silver-on-glass mirrors have brought into considerable prominence the reflector especially for photographic work.

Gathering together all the photographs made from the time of Rutherfurd (1874) to the present, and later, will put into the hands of the selenographer means of determining the changes on the moon. Changes we most certainly expect. We are not aware that there exists anything which does not undergo change. But these changes may be so small and so slow to us that it may take years to discover them.

The surroundings of the sun—that region which comes into view only at the times of total solar eclipse—the sun's "crown of glory," the corona—at present can be studied for about an hour during a century, if we estimate the time the astronomer has been able to actually see the corona.

But photography has here brought us most satisfactory results. Many negatives are now obtained at every eclipse of the sun, and these can be studied and measured at leisure. At an observing station for a total solar eclipse, the astronomer of fifty years ago would be dumfounded to see how few and how small are the instruments set aside for the eye observations. All the large instruments and most of the observers' time are given to the photographic work. How fortunate this is—for not only can the originals be studied with great care, but copies can be furnished to all astronomers the world over for inspection and for comment.

In the past the discovery of new planets always excited a deep interest in the minds of men. To-day we are so accustomed to the discovery of new minor planets (sometimes as many as twenty-eight in one year) that we pass them by without much notice. You no doubt remember that the astronomers of the eighteenth century had great faith in Bode's law. This law stated that the planets were arranged in order of distance from the sun according to the numbers, 4, 7, 10, 16, 28, 52, etc. These numbers were obtained by writing down the numbers 0, 3, 6, 12, 24, 48. All the numbers after the second were obtained by multiplying the preceding number by two; and then adding four to each result. Representing the earth's distance as 10 the other numbers represented very fairly the distances of the other planets, but there was a break at 28. No planets were known at the distance 2.8 times the earth's distance from the sun. The law was so firmly believed in that in the latter part of the eighteenth century a number of astronomers joined in the search. They were dubbed the "celestial police." The first fugitive planet was found by Piazzi, January 1, 1801, an astronomer of Sicily, who had not yet received notice of his appointment on the force.

Then the search was later taken up most vigorously, and down to 1892 about 325 were discovered. But in the latter part of the preceding year Dr. Wolf, of Heidelberg, inaugurated the scheme of photographing the heavens. He made his exposures in duplicate, and for two or three hours. The result was that if a minor planet was in the field, as the telescope was guided by following accurately a star, the planet's moving caused a short dash to appear on the plate instead of a round star image.

The plates were measured and from these measurements the astronomer could determine whether the planet was new or an old one. In carrying out this work Dr. Wolf, Charlois of Nice, and others have been so successful that, since November 28, 1891, the list of minor planets, mainly discovered by photography, has increased to nearly five hundred. Wolf's work attracted the attention of the late Miss Catherine Wolfe Bruce, of New York city, who has done so much for astronomy. Miss Bruce gave Wolf the means to build a fine photographic outfit. The new apparatus he had built in this country, and is now using with the most excellent results. He has immortalized that noble, generous woman by naming one of the planets Brucia. He showed his appreciation of the work of the Lick Observatory by giving the appellation of California to the planet he discovered on September 25, 1892, and he had previously named another Chicago, after the city he expected to visit during the Exposition of 1893.

Photography has so rapidly increased the number of these little planets that there has been some serious discussion as to whether it may not be wise to let them go; the calculations and observations necessary to keep track of them are considerable and expensive.

This method by the use of larger lenses, longer exposures and more sensitive plates, may show thousands of little bodies, circulating not only between the orbits of Mars and Jupiter, but even between the orbits of all the other planets.

If celestial photography had been known in 1846 and previously, then the discovery of Neptune would have been made by Challis at Cambridge, England, with great ease.

It was by photography that Herr Witt in 1898 discovered that most interesting minor planet named by him Eros. This is the first body whose orbit has been proved to lie mainly within the orbit of Mars—moving in such a path that at perihelion the earth and planet are separated by about 15,000,000 miles. Here, then, we have a grand opportunity for determining its parallax and so getting a new value of the sun's parallax, and hence its distance in miles. Such use has already been made of Eros. A large number of observatories took in 1901 photographs of the planet, and these are to be measured and reduced. But Eros will be better situated in later years, so that during the twentieth century the sun's distance will be obtained with great accuracy. To-day we know that distance with an uncertainty of about 150,000 miles; at the end of the century the uncertainty ought to be reduced to 25,000 miles or less. Under the most accurate methods of the present day base lines on this little earth can be measured with an error of even less than one part in a million—or one inch in a million inches, i. e., one inch error in measuring a line nearly sixteen miles long, or half an inch error in measuring a line nearly eight miles long.

Such accuracy we can hardly hope to reach during the twentieth century in obtaining the distance of the sun from the earth. Such an error would amount to over ninety miles. One mile seems a large unit to us, but it is an exceedingly small measuring unit for sounding the depths of space.

The business men of the world are proving to us that there is a great benefit for some one in big combinations of shops and men. The effect in some cases has been to improve machinery, better the output and to reduce prices. This idea of co-operation has taken hold of the scientific mind. To-day seventeen observatories are engaged in making maps of the heavens by photography. Seventeen observatories from Fin-

* Commencement Address delivered at the Worcester Polytechnic Institute, June 12, 1902.

land to the Cape of Good Hope have been busy for the past ten years in obtaining the images of stars on the sensitive plates. Their plan is a most interesting one for the astronomer. It was arranged by conferences of astronomers who met several times at Paris. The heavens have been divided into belts parallel to the equator, and each observatory photographs one or more belts completely around the sky. In order to guard against error a peculiar system has been adopted; each plate is exposed for twenty seconds, the telescope in the meantime following the star with great nicety. Then the plate is moved a trifle and another exposure is made lasting three minutes, and in a similar way a third exposure is made for six minutes. These three images of a star are very close to each other Every bright star will make three images. The faint stars will give only two images and the very faint stars one image. This enables the astronomer to judge of the brightness of the stars, and also to discriminate between defects on the plate and real images. In order to tie a plate to its neighboring plates they are made to overlap, so that twice the number necessary to once cover the sky is taken. This makes 22,000 plates. Many of these have now been made and the plates have been measured to determine the relation of the stars to each other. The catalogue to be published is likely to contain about 2,000,000 stars down to the 11th magnitude. When done, we shall have the most valuable and extensive star catalogue ever constructed.

In addition to these plates the observatories doing this work will also take plates with exposures lasting thirty to fifty minutes (depending on the atmospheric conditions). These plates will probably show some 20,000,000 stars.

To measure their positions and to reduce the measurements would require much time and money—more than the astronomers and their patrons can afford to give. It has been decided, however, to enlarge these plates by proper lenses and to make a heliogravure of the enlargement. The liberal French government has been the first to publish a large number of these charts, which show stars down to the fourteenth magnitude and are invaluable for studying at leisure a given part of the sky. Each plate covers about four square degrees.

In our own country Prof. E. C. Pickering, of Harvard College Observatory, has employed the Bruce telescope and other instruments to make photographs of the heavens. Pickering by his system is able to take a larger area on each plate and finish his survey in a shorter time. He has thus been able to collect a magnificent library of plates which have proved most valuable in the past and are likely to prove more precious in the future. Professor Barnard and others have given considerable time to using instruments which show large areas of the heavens with exposures of several hours. The wonder-exciting result is obtained showing that the number of stars goes on increasing. When will it end? What does it mean? The astronomer bows his head in awe-full ignorance!

To-day we are all amazed by the promises of wireless telegraphy. Messages across the ocean seem likely to be coming soon from every direction without going through cables.

Wireless telegraphic communication with the sun, planets and stars the astronomer has had for some time past. The messages are received by a specially devised apparatus called a photospectroscope, and the cipher dispatches are styled spectra. These spectra are photographed on glass and are measured, reduced and interpreted by the expert. In the use of this instrument our own country has done much, and the names of Young, Pickering, Langley, Keeler, Campbell, Hale and others stand high in the list of astrophysicists.

What are the stars made of? What materials are in the sun and in comets? in nebulæ? The light from these bodies speeds onward with a velocity of over 180,000 miles a second and takes more than four years to come from the nearest star. Even to come from the sun requires about 500 seconds of time. These light vibrations enter the telescope and pass into the spectroscope, and proper apparatus enables us to obtain a message which tells us what are the gases in the sun, stars, comets and nebulæ.

Moreover, this resultful instrument gives us the power to determine motion and its rate to and from the observer. The stars are so distant that a line 93 millions of miles in length would look to the inhabitant of the nearest star as a line about two-tenths of an inch long would appear to you when placed a mile away!

Motion to or from us of an object so far away has hitherto been impossible to measure. The spectroscope solves the problem. If a star is moving toward us then there is a displacement of lines in the stellar spectrum toward the blue end, and if it is going from us the displacement is to the red end. By proper comparison-measurements the rate of motion can be worked out. This information is most important for the purpose of calculating the orbit or path in space of the star examined.

Then, too, the same principle gives us the power to measure the rotation times of the sun and planets, because we can bring into view two opposite sides of the sun or the planet's disk; these opposite sides revolve, one toward us, the other away, and the spectra of the two sides show displacements of lines in opposite directions. The amount of displacement gives the velocity of rotation. For the sun and planets these results obtained by the spectroscope are checked by independent observations, such as watching the spots on the sun and on Jupiter.

The power of the spectroscope to measure motion in the line of sight has recently been used by the late director of Lick Observatory, California, Keeler, and by the present director, Dr. Campbell, in solving two most interesting problems. When Saturn's rings were first discussed, it was thought they were solid. Then it was shown that a ring system nearly 170,000 miles in diameter and about 100 miles in thickness could not endure, without destruction, the diverse pullings due to the gravitation of forces exercised by the planet and the satellites. A fluid system of rings was found to be unstable also, and the theory was adopted that the rings are composed of millions of small satellites so aggregated that they reflected sunlight to us and gave the appearance of solidity, like a cloud in the summer sky. This theory of the structure of the rings was styled the meteoric theory: it rested almost entirely on the mathematical argument. But Keeler in 1895 confirmed this theory in a beautiful manner by the use of his spectroscope. The slit of the spectroscope was made to pass through the center of the image of the planet and through the rings, and he obtained a photograph of the spectra of the rings and the planet. Then, on examination, the lines in the spectra were found to be conspicuously inclined, and inclined in such a way that the planet was shown to be revolving as a solid body, while the rings were revolving only as they could revolve if composed of separated satellites. Thus we have the final proof that the rings are neither solid nor liquid, but are meteoric. Keeler's results have been confirmed fully by other observers.

The question has often been asked, "Does the solar system as a unit remain fixed in space, or is it moving in a known direction?" How can this be determined? When we look down a long straight line of railroad track we note that the separate tracks appear to come closer together as the distance sighted becomes greater, and if the distance is long enough the tracks appear to actually come together. Now if we walk down the track we discover that this coming-together point moves away from us—the tracks open in the direction we are walking and on looking back the tracks appear to be closing in. An effect similar to this would show itself when we look at the stars, if the solar system is moving in space. Those stars, situated at the point toward which we are moving, will gradually open out, separate, and those stars in the opposite direction would appear to be coming together.

Observations have been made to determine these directions; with the result that they seem to show that the sun, carrying with him his family of planets, is moving toward a point near the eastern edge of the constellation of Hercules, with a velocity of about fifteen miles a second. But observers differ quite a little in their results. Campbell has undertaken to investigate the subject of studying the velocity of stars in the line of sight by the use of the spectroscope. The examination of many hundreds of stars ought to bring out the result, that in the direction we are moving the general average displacement of lines in the spectra should be toward the blue end, and the opposite effect would show itself in examining stars in the direction from which we are moving. Campbell has examined many stars in the northern sky, and soon will go to Chili to continue his observations. The final result will give us both the point among the stars toward which the solar system is going and the velocity. These facts being known, the astronomer may be able in the future to calculate when the sun and his family will come into dangerous proximity to other great systems in space. Such thoughts need not worry us as the time is to be reckoned in thousands of years!

The spectroscope applied to sun, planets, stars, nebulæ, comets and meteors, has given us a splendid record, and the present century is full of promises of greater results.

To-day in all great observatories photography is used to obtain permanent records of sun, planets and stars, etc. When we study the photographs taken, we are impressed with the fact that our sensitive plates, when exposed to an object, will show on development more and more, depending on the time of exposure. The startling information is obtained that after from ten to twenty-five hours or more exposure we can obtain a photograph which will show us what we never can hope (as far as we now know) to see in our telescope! Let us give our imaginations free rein, and we may dream of getting only general information with our eyes, but by the use of sensitive plates in photography, we may make amazing discoveries all around us of things the eye cannot see.

In conclusion let me quote the words of one of our ablest workers in celestial photography:

"If we were asked to sum up in one word what photography has accomplished, we should say that observational astronomy has been revolutionized.

"There is to-day scarcely an instrument of precision in which the sensitive plate has not been substituted for the human eye; scarcely an inquiry possible to the older method which cannot now be undertaken upon a grander scale. Novel investigations formerly not even possible are now entirely practicable by photography, and the end is not yet.

"Valuable as are the achievements already consummated, photography is richest in its promise for the future. Astronomy has been called the 'perfect science'; it is safe to predict that the next generation will wonder that the knowledge we have to-day should ever have received so proud a title."

THE DEAD SEA AS IT IS TO-DAY.

The Dead Sea is about four miles from Jericho. There is no road; there are no bridges, but during the dry season a wagon may cross the barren plain almost anywhere, for it is like the Bad Lands of Dakota, except that the surface is coated with salt and gypsum instead of alkali. During the rainy season it is impassable.

The Dead Sea occupies a sink inclosed on three sides by precipitous and barren mountains. On the Moab shore they rise to the height of 3,500 feet, and the Jerusalem side to 2,500 feet, and touch the water in two places, being cut by rocky gorges. The Dead Sea is almost the shape and dimensions of Lake Geneva in Switzerland, being forty-seven miles in length and nine and a half miles wide at the widest part. Near the center it is less than two miles wide. At the northeast corner, not far from the mouth of the Jordan, soundings show a depth of 1,310 feet. From there southward the bottom shelves rapidly upward, and at the southern extremity it is only eight or twelve feet deep. The mean depth is 1,080 feet. The variation in depth during the year is often as much as twenty feet, according to the rainfall. The normal level below that of the Mediterranean is 1,292 feet; the total depth of the depression below the level of the Mediterranean is 2,603 feet. Jerusalem is 2,494 feet above the Mediterranean and 3,786 feet above the Dead Sea.

Scientific observation justifies the estimate that a daily average of 6,500,000 tons of water is received into the sea from the Jordan and other sources during the year. During the rainy season the amount is very much greater; during the dry season it is, of course, very much less, but this average will be maintained year after year. There is no outlet and the level is kept down by evaporation only, which is very rapid because of the intense heat, the dry atmosphere and the dry winds which are constantly blowing down from the gorges between the mountains. This evaporation causes a haze or mist to hang over the lake at all times, and when it is more rapid than usual heavy clouds form and thunderstorms sometimes rage with great violence in the pocket between the cliffs, even in the dry season. A flood of rain often falls upon the surface of the sea when the sun is shining and the atmosphere is as dry as a bone half a mile from the shore. The mountains around the Dead Sea are rarely seen with distinctness because of this haze.

The waters of Jordan when they reach the sea are as brown as the earth through which they flow—a thick solution of mud—but the instant they mingle with the salt water of the lake the particles of soil are precipitated and they become as clear as crystal, with an intensely green tint. Carrying so much soil and having so swift a current, one would suppose that the sea would be discolored for a considerable distance, but it is not so. The discoloration is remarkably slight. The Jordan has quite a delta at its mouth, breaking into a number of streams and frequently changing its course because of the obstructions brought down by its own current.

All the streams which feed the Dead Sea are more or less impregnated with sodium, sulphur and other chemicals, hence the water contains an unusual quantity, at least 26 per cent of solid substance. Seven per cent of this is common salt, 6 per cent is chloride of magnesium, which gives the water its nauseous and bitter taste, and 5 per cent is chloride of calcium, which makes it feel smooth and oily to the touch. There are several other ingredients in smaller quantities. The water boils at 221 deg. F. Its specific gravity varies from 1,021, where it receives the discharge of fresh water from the Jordan, to 1,256 at the southern part, near a ledge of rock salt. Salt has been collected and sold in the neighboring cities from the earliest times and is considered particularly strong.

At the bottom of the lake are large beds of asphalt, and the surrounding soil is rich in bituminous matter. Small lumps of bitumen, which is solidified petroleum, frequently float upon the surface, and may be picked up among the gravel on the shores. At the southeast corner is a ridge of pure rock salt five miles long and 300 feet high. A pillar that rises beside it is pointed out to tourists as the remains of Lot's wife. This deposit of fossil salt is said to contain a higher percentage of chloride of sodium than is found elsewhere. The bottom of the lake in that vicinity is covered with large crystals so hard as to defy solution except in boiling water.

Nevertheless, the water of the Dead Sea is not the saltiest in the world, as is generally supposed. Ocean water contains 4 per cent salt; the Dead Sea 26 per cent, the great Salt Lake of Utah 14 per cent in the rainy season and 22 per cent in the dry season; Lake Elton, on the Kirglin Steppes of Siberia, east of the Volga River, 29 per cent, and Lake Uramia, in Persia, is said to contain from 28 to 32 per cent. The latter is strongly impregnated with iodine also.

The water of the Dead Sea is very nauseous. No stomach is strong enough to retain it. It is sticky to the touch, and, when dried, leaves a coating of salt and other chemicals upon the flesh of bathers. But it is a beautiful blue color, and so transparent that one can distinguish objects upon the bottom at a depth of twenty feet. It is difficult to swim in because of its buoyancy. A human body floats without exertion, and can only be submerged by an effort. Swimming is unpleasant, as the feet, being the lighter part of the body, have too great a tendency to rise to the surface. The sea is usually perfectly calm. The water is so heavy that it requires a strong wind to disturb it.

Fish placed in the Dead Sea gasp a few times and die, and the only living things that exist in the water are a few microbes, the bacilli of tetanus, which have been discovered in the north bank. The popular supposition that poisonous exhalations arise from its surface is a mistake. Birds fly over it without injury, and no baneful effects are suffered by breathing the atmosphere. On the contrary, consumptives and other persons of delicate health have found the air healing and stimulating, notwithstanding the great heat, and frequently camp upon the shores. At one time several colonies of hermits lived upon the shores, and within a century penitents have come here to die among its repulsive surroundings. There were formerly several boats plying the waters, bringing merchandise from the opposite shores to Jericho and for the accommodation of tourists. At present there are but two, and one of them, a small steamer recently brought over in sections from Alexandria by the treasurer of the Orthodox Greek Church at Jerusalem for excursion purposes, is laid up under a prohibition from the Governor of the province, who has not received the amount of baksheesh to which he thinks himself entitled.

A great deal of mystery and superstition attached to the Dead Sea in olden times, much of which was dissipated by a thorough exploration made by Capt. W. F. Lynch, an American naturalist, who was sent over by the Palestine Exploration Society of New York in 1848. His report has ever since been regarded as the highest authority on all questions, although several points are still disputed. Certain passages of Scripture can be reconciled to the physical conditions that exist to-day only upon the theory that the climate and topography have changed in a radical and remarkable manner. According to the fourteenth chapter of Genesis, there was already a salt sea here in the days of Abraham; the valley of Siddin, as it was called, "was full of slime pits," and somewhere in this awful and uninhabitable region was the scene of God's most ter-

rible punishment of human sins. The glare of the fire and brimstone that rained upon Sodom and Gomorrah still illuminates this repulsive plain.

When Abraham and Lot looked down from the Mountain of Bethel (which is not satisfactorily identified), the valley of the Jordan was well "watered everywhere as the garden of the Lord, and like unto the land of Egypt." The longing eyes of Moses gazed from Pizgah over a landscape of beauty and delight; at the temptation of Jesus the plain of Jericho was covered with fertile fields where now are banks of naked, lifeless clay, bearing no vegetation but grease plants and sage brush.

From no point of view that could have been occupied by Abraham, Moses or Jesus does the valley of the Jordan appear anything but a desolate waste of mud.

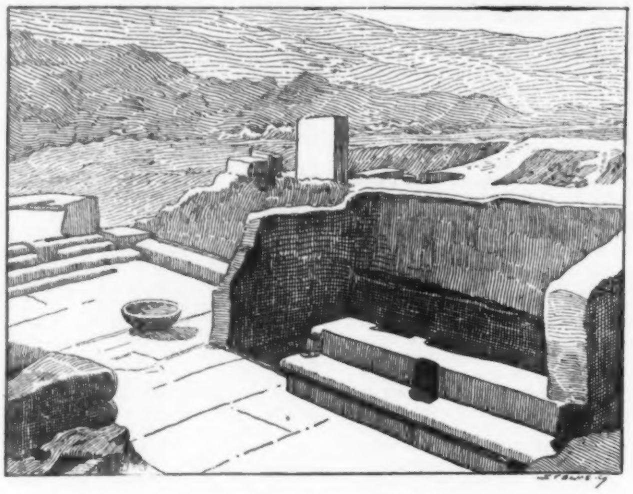
There were once five cities—Sodom, Gomorrah, Adnah, Zeboiim and Zoar—but no man can tell where they stood. Their ruins have entirely disappeared, and careful investigation has demonstrated that the popular idea that Sodom and Gomorrah lie at the bottom of the Dead Sea is a mistake. It is also a mistake to suppose that any community of size ever existed in this climate, where now no man can live.

Just how the Lord "overthrew the cities" is not disclosed, either by Scriptural history or the evidences of nature, or the appearance of ruins. The inquisitive explorer can gain no light from any of these three usually reliable sources. The great difference in level between the Sea of Galilee and the Dead Sea has often been cited as evidence that they were submerged by the sinking of the surface of the earth, and it has often been suggested that a flood might have followed an earthquake or the eruption of a volcano; but geologists are confident that no active volcanoes have ever existed in this vicinity and that the subsidence of the Jordan Valley occurred in the tertiary period, which was ages before it could have been inhabited by men. They hold that this pocket in the mountains was a reservoir in the first ice age, when, as the testimony of the rocks in the adjacent mountains proves, the water level was some 3,000 feet higher than at present and at a greater elevation even than the surface of the Mediterranean.

It is also perfectly clear from the Scriptures that the catastrophe which overtook the five cities upon the plain was not from water but from fire, and the absolute disappearance of all traces of walls that must have been built of stone, because there was no timber, is of itself a remarkable phenomenon. This is, perhaps, the only place in Palestine where the Bible student is utterly bewildered because of the contradictions between the land and the Book.—From the Chicago Record-Herald.

AN EXCURSION TO THE HOUSE OF MINOS.

Leaving the museum at Candia, the most populous town in Crete, let us set out for the field of the excavations at Knossos. Outside the ramparts of the town we find ourselves in a bright country sown with olive and fruit trees. Soon we see in the distance Mount Ida silhouetted against the sky like a gigantic cone set in the middle of the plain, and after about an hour's ride on ponies the excavations are reached. They at first surprise us, for there is no acropolis, no eminence—nothing to suggest a place so famous. But there, in a great plot, lies the excavated Palace of Minos, the disposition of which is shown by the accompanying plan. It is seen that the eastern terrace, which formerly seemed to be part of an esplanade encircling the palace, forms in reality a great interior court bordered by two groups of buildings. Among the newer excavations made on the slope that leads to the river are seen some small store-rooms, an olive press, a small court inclosed by a colonnade and a large room for devotional exercises; and, lastly, what is most curious, a stair with four stages and about fifty steps leading to a higher level. It should be remembered that all these rooms are of medium size—the largest of them is only about 30 feet long by 15 feet wide—so that there is nothing to recall the enormous proportions of the Assyrian palaces or the Egyptian temples. Some corners of the excavations have the picturesque appearance of Pompeii, particularly the twenty small storerooms arranged off a long gallery on the western side of the palace, where are about fifty tall jars, intended to be used for provisions, grain, wine and oil—such jars as the forty thieves might have hid in. In the floors of the rooms themselves small rectangular pits (in some cases sheathed with metal plates) have been dug for the reception of the more precious objects; but nothing has been found in them, for, after the fire which laid waste the palace, and of which traces are visible in many places, the inhabitants decamped with everything of value.

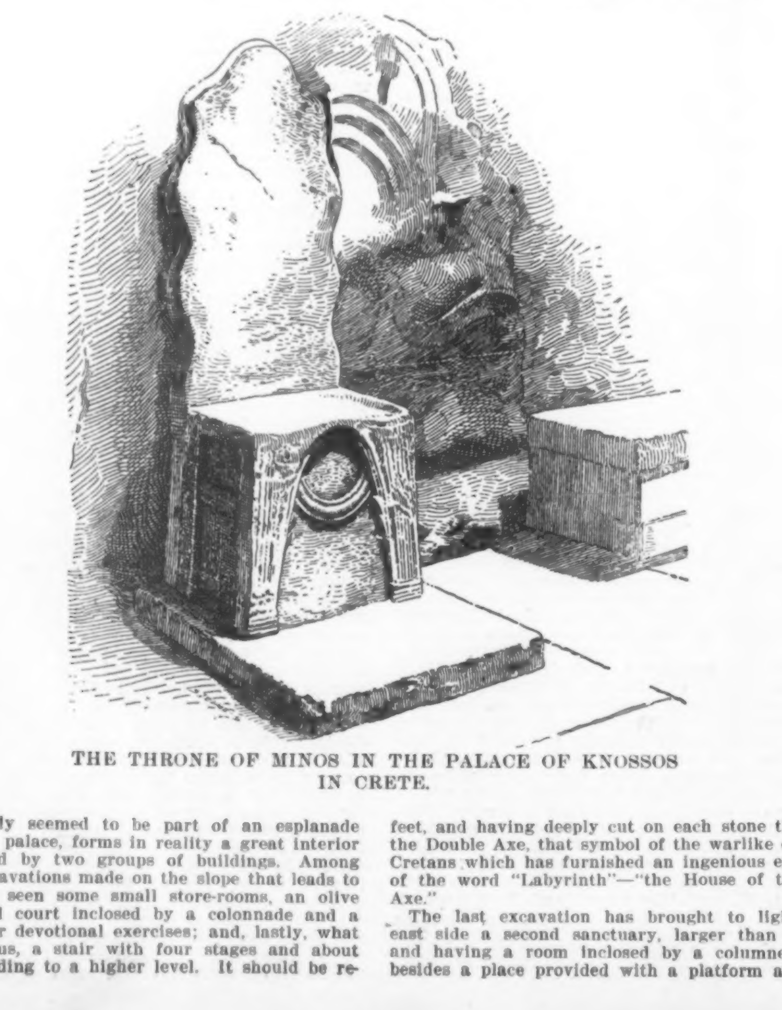


POOL IN THE THRONE ROOM.

On the south side a flight of steps leads to the propylea which, judging by the fragment of rose-work that has been discovered (and is here illustrated), must have been very beautifully decorated. The molding of the petals and the pleasant curves of the corollas are rendered on the stone with a delicacy which suggests the best works of classic Greece. Were this fragment found in the vicinity of the Erectheum it would not disgrace the collection of magnificent fragments strewn around the Athenian citadel. One understands how much the Ionic order owes to its archetypes which, in Crete and elsewhere, drew from the plant and the flower the classic elements of stone decoration.

The great central court gives access, on the west side, to three groups of buildings—to the left, a chapel; in front, the reception room; and to the right, the women's apartments, in each of which have been found monuments or personal objects adapted to the uses of the building.

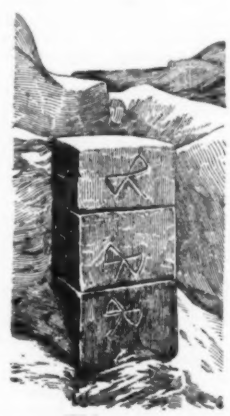
The sanctuary is recognizable by two pillars formed of large square blocks arising to a height of about 6 feet, and having deeply cut on each stone the sign of the Double Axe, that symbol of the warlike cult of the Cretans which has furnished an ingenious explanation of the word "Labyrinth"—"the House of the Double Axe."



THE THRONE OF MINOS IN THE PALACE OF KNOSSOS IN CRETE.

The last excavation has brought to light on the east side a second sanctuary, larger than the other and having a room inclosed by a columned portico, besides a place provided with a platform attached at the bottom of the wall and covered with incised signs of the sacred bipenne. It is probable that on top of the pillars themselves were placed instruments of war—axes and clubs—as one sees figured on some Oriental cylinders.

The adjoining part of the palace has an air of luxury and comfort. After crossing a small vestibule one enters the reception room, called the "Throne Room" on account of the large stone seat which forms its chief embellishment. This seat, as will be seen by the accompanying illustration, is raised on a flat flag stone and has the appearance of a throne; and the originality of its forms proves better than anything else how much Cretan art preserved its individuality in the face of Egyptian and Chaldean models. This throne with its curved outline and pointed ornament below the seat—this chair of wood translated into stone—is more like a Gothic prie-dieu than a pre-Hellenic piece of furniture.



THE PILLAR OF AXES.

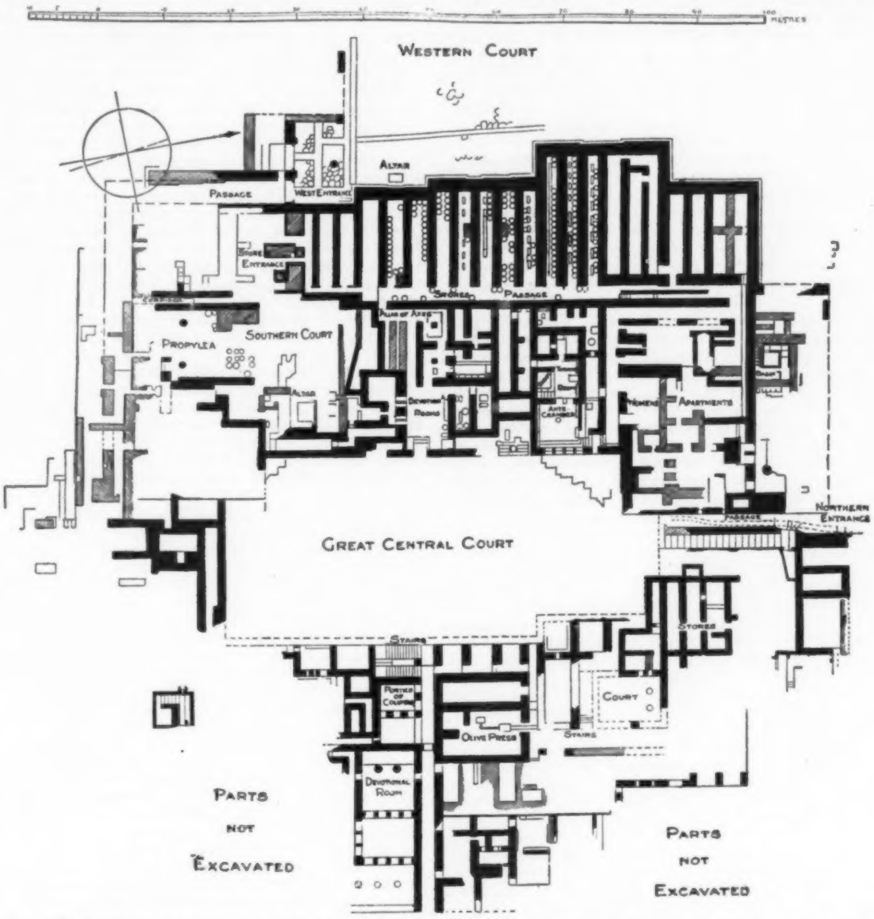
The benches on either side and in front of the throne are very simple; they are formed of square blocks of well-polished stone without moulding of any sort, but their construction is remarkably careful. Homer's verses come to mind where the seniors of the people are represented "seated on polished stones and holding in their hands the scepters of the sonorous voiced heralds." To reconstruct a similar scene in the hall of Minos is no effort, and it is a dramatic evocation of that king of old of whom legend has made a kind of cruel magician, whereas, in reality, he was the chief legislator of barbarian Europe.

One other curious detail completes the appearance of the room. In front of the throne is a deep hollow to which one descends by steps cut in the stone. The bench at the brim of this hollow has three wide notches in which the beams fitted for supporting the roof-covering of the pit; and as there is no trace of any cutting for water it is certain that the roof received the rain and let it fall into the pool; so that, in a country burnt with heat, the architect had the ingenuity to utilize these reservoirs for cooling the rooms, and we thus have here what afterward became the

FRAGMENT OF SCULPTURED ORNAMENT.

atrium of the Romans and the most ancient example of the Latin *impluvium*. The disposition of the bathrooms in other parts of the palace is analogous, and above one of them, by a happy conception, is a decorated frieze representing fishes swimming.

The decorative painter naturally played an important part in this throne room, and here were the landscape paintings and the two crouching griffins to be seen in the museum at Candia. The position of the harem is also known by the paintings on the walls of the northern rooms; in fact, each part of the building was decorated appropriately to its uses.



PLAN OF THE PALACE OF KNOSSOS, CRETE, EXCAVATED UNDER THE DIRECTION OF MR. ARTHUR EVANS.

Of the numerous objects discovered in this wonderful palace there is now no space to speak, but a brief reference should be made to the clay tablets—numbering more than two thousand—on which an unknown language is cut. Should these strange characters ever be deciphered, then we shall know of what race was this mysterious people.

But it is time to journey back to Candia, whence we go with a vivid impression of this resurrection of the Cretan world—made possible by the work of Mr. Arthur Evans and his comrades on the site of Knossos.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from an article in La Revue de l'Art Ancien et Moderne.

THE NEW WEATHER VANE OF THE EIFFEL TOWER.

LAST year, the Central Meteorological Bureau had M. Chateau install upon the Eiffel Tower a new weather vane electrically connected with Rue de l'Université. As this vane has now undergone the victorious test of experience, it will prove of interest to give a few data in regard to it. The system of transmission naturally consists of two elements—a transmitter and a receiver. The former (2) is installed alongside of the vane itself, and the receiver (3), which is housed at the Central Bureau, reproduces its indications and registers them upon a chart. The principle employed in the transmitter and receiver is that used in the striking trains of what are called "regulating clocks." The vane (1), which is formed of two copper wings and revolves in ball bearings, transmits the motion of its axis to a cylindrical cam, upon which is capable of falling the point of a toothed sector (*A*). This sector, after falling, is capable of being raised by an electro-magnet (*B*), into which a clock (5) causes an intermittent current to be sent by rapidly making and breaking the circuit thirty-two times in succession.

The receiver consists of a sector with rack (*C*) identical with that of the transmitter, but which falls back upon a fixed stop instead of on a variable cam. The lower part of the rack sector in this instrument is provided with a tracer which describes a curve upon a sheet of paper wound around a drum (*D*) and divided longitudinally into 32 equal parts that correspond to the 32 points of the compass.

The sheet of paper is moved along lengthwise every time the rack sector descends. The regulating timepiece every half hour (or oftener if desired) sets in motion a clock train that produces 32 friction contacts, as well as a contact designed to bring about the release of the rack sectors. The system operates as follows:

The apparatus being at rest, the clock makes a connection so that a current is sent through the electro-magnet above it, the armature of which makes a contact that causes a current to pass through the magnets *B* and *B'* of the transmitter and receiver in order to release the rack sectors and cause them to descend. That of the transmitter falls upon the variable cam stop controlled by the vane, which limits its travel.

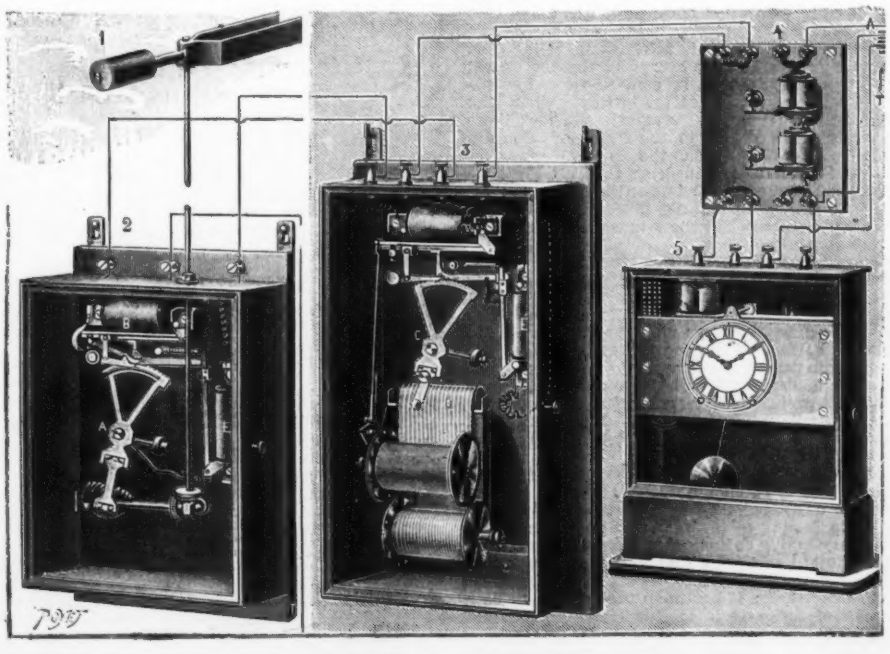
Almost immediately afterward the clock-train that makes and breaks the circuit of the lateral electros (*EE'*) is set in motion. The circuit of these magnets, the movement of the armatures of which raises the rack sectors tooth by tooth (each sector has 32 teeth), is made and broken 32 times in rapid succession or less, according to whether the sectors have swung downward to the full extent or not. In this manner the sectors are returned to their original position, the operating current of the magnets being automatically shut off as soon as they reach it.

During the raising of the rack sector of the receiver, the tracer on it inscribes upon the paper a curve, the length of which gives the exact direction of the wind. This series of operations is repeated every half hour, or as much more frequently as it is desired to register the wind's direction.

The clock controls only local currents that act upon a relay (4), and there is consequently no danger of the delicate parts of the apparatus being injured by a strong current from accumulators or a dynamo, nor is there any danger of the polarization of the battery in case of a stoppage from any cause whatever. The number of current pulsations in the magnets is reduced to exactly 32, which are produced at intervals of half a second.

Since the ordinates (which, as a whole, give the general outline of the wind's direction for the day) are traced in parallel every half hour or oftener throughout their entire extent, there is never any possibility of an accumulation of errors, and the indications of the vane are transmitted to the registering apparatus in an absolutely exact manner.

The apparatus has, ever since its installation, given excellent results, which are due as much to the simplicity of its principle as to the excellence of its construction.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.



REGISTERING WEATHER VANE.

1. Vane. 2. Transmitter. 3. Receiver. 4. Relay. 5. Current-controlling clock.

THE BIOGRAPHY OF A SNOWFLAKE.

By ARTHUR H. BELL.

IT is one of the most interesting things in connection with the subject of the weather that all its phenomena are so closely in touch with one another, and that in order to explain any one of them it is necessary to take account of all the rest. A further fact is that the various phenomena have a power of transforming themselves very quickly as it were into something else, so that it is often a long process to hunt down and discover what is the fundamental structure of these fugitive shapes. A snowflake, for instance, at first sight might be thought to have a separate existence from any of the other children born of aqueous vapor, but on attempting to follow up the history of these "frozen flowers," as Professor Tyndall called them, it is found that the attention is at once directed to the consideration of such things as rain, hail, sleet, mist, dew, hoarfrost and clouds. Hail, rain, sleet and snow are, of course, very nearly related indeed, but similarly to the other phenomena they are all built up out of aqueous vapor, and when vapor is condensing out of the atmosphere it is, at some seasons of the year, quite as likely to take one shape as another. Of the phenomena mentioned above hail is probably the most noisy in its descent from the atmosphere to the earth, and this more especially when it happens to be accompanied by a thunderstorm. On the other hand, hoar-frost and snow are probably the quietest of all the children of the air, while as regards their picturesque effects, who would venture to decide between two such skillful artists? Snow, which is the parent of the grinding glacier and the stupendous iceberg, has, however, such notable effects on climate and on weather that few meteorological phenomena can compare with it for interest.

Now it is probable that, as is the case with a raindrop, or with hail, in order to give a snowflake a start in life there must be a tiny nucleus of dust, round which the condensing vapor may gather. It is mainly a question of temperature as to what form this condensing moisture will take, but commonly when the temperature is above the freezing point rain is the outcome. When this process takes place in a body of air at or about the freezing point, snow gets its opportunity; while when the condensed moisture does not at once freeze solid, hail will be more likely to occur. At some times, indeed, both snow and hail take the form of little fluffy pellets of frozen moisture, and considerable experience is necessary to distinguish between them. As a general rule, the colder the weather the smaller the snowflakes, the large flakes, which children describe as being due to the old woman plucking her geese, appearing when the thermometer is not far away from the freezing point. Large flakes, indeed, are a conglomeration of smaller flakes, and it is in the latter that the greatest regularity and beauty of structure are to be seen.

In order therefore that a snowflake may make a successful journey through the atmosphere it should be built up on a particle of dust, while if it should be fortunate enough to commence its career at the top of a cloud soaring many miles above the level of the earth, it will thereby become still better equipped for adding to its stores of frozen vapor. Between the growing snowflake and the earth, it should be borne in mind, there are in ordinary conditions strata

of atmosphere that differ very much as regards their temperature and the amount of moisture they contain. These different layers through which the descending snowflake will pass favor its development, for it often happens that in one layer of atmosphere the flake gathers moisture which is promptly frozen in the succeeding layer. In this connection it is well to recall what happens when one holds a snowball, or two pieces of melting ice in a warm hand for any length of time, for either can be welded into a solid lump by a little pressure, a process commonly called regelation, and to be borne in mind when seeking for the causes that favor the growth of a snowflake.

From each layer of atmosphere through which it passes the fluttering snowflake may therefore be thought of as collecting a tribute of moisture, but unlike a hailstone it makes these accretions in gentle fashion. There is a fuss and a dash with the downward plunge of a hailstone, so that the frozen moisture is welded around it with great force and it quickly grows hard and solid. On the other hand, with a snowflake the frozen moisture is not so much welded as it is enmeshed, for on every snowflake, even in its early moments, there are protuberances and spicules that catch the floating moisture as in a tiny net. The most common forms of snowflake have a solid nucleus with rays ramified in different planes, others taking the shape of six-sided needles or prisms, or six-sided pyramids. A complicated snowflake takes the form of a six-sided prism from one or both ends of which six-sided plates are projected. Another kind of snowflake is found to be simply a thin lamina of frozen moisture, snowflakes of this class being observed in great variety. Many interesting sketches have been made of all these different kinds of snowflakes, but this is work that requires further elaboration by some observer willing to devote a little time to this most interesting work of taking a picture of the snowflakes as they reach the earth. It has been said that the crystals in any given snowstorm have a family likeness, each storm, as it were, having its own particular type of snowflake. This is an interesting point to be settled only by careful observation, and for the present it is enough to recognize the fact that although snowflakes seem all very much alike yet there is endless variety in these "lovely blossoms of the frost."

It will be seen, then, that the conditions most favorable for the production of large snowflakes are when the atmosphere is freezing in some parts and thawing in others. With these conditions the process of regelation of moisture on the surface of the snowflake will proceed apace. Under such favorable circumstances very large flakes may be built up, although, as already mentioned, these large structures are often but the result of flakes that have collided in mid air and joined forces. These large snowflakes are like very large hailstones which are often but a mass of ice formed by several hailstones crushed together. Both as regards the snowflake and the hailstones, these conglomerates are not properly to be taken as showing to what size a single flake or stone may grow. With this proviso it may be stated that one of these conglomerate snowflakes was found to measure 3½ inches in length, 1½ inches in breadth, and 1½ inches in thickness; the flake when melted yielded 2½ cubic inches of water. Such large snowflakes as this cannot come to maturity when the atmosphere is of a very low temperature all through. In such circumstances there are no alternate layers of air of varying conditions in temperature and moisture, and as a result only small, dry flakes of snow are produced. This is the kind of snow that falls in the polar regions, and it is these cold weather snowflakes that are the most perfect in form. Closely allied to the small and the large snowflakes is sleet. This commonly is objurgated as the most unpleasant of all the children born of the atmosphere, but it will perhaps be seen that rightly to understand the whole story of a snowflake, something of the changes in temperature that produce sleet need to be taken into account.

When lying on the ground, snow, from a meteorological point of view, is of much greater interest than when falling through the air. In an ordinary way there is a constant exchange of heat between the surface of the earth and the atmosphere. Thus during the day the sun pours its warmth down through the air to the earth, so that the surface of the ground is raised in temperature. During the night hours this acquired warmth is rapidly radiated into space, and the temperature of the earth accordingly falls. The atmosphere, moreover, that is everywhere in the closest intimacy with the ground, is also affected by this prodigal behavior of the earth. Now, when the ground is wrapped round in its mantle of snow, these imports and exports of heat to and from the earth are interrupted. In other words, the diurnal range of temperature is greatly modified, so that all the time snow is on the ground there is not that excessive expenditure of heat that ordinarily takes place, and as a result the soil beneath the snow is maintained at an equable temperature.

Anyone who has been on the snow a few thousand feet above the level of the sea will have recognized the fact that snow is a good radiator of heat. At such a height, moreover, the atmosphere is dry and free from dust, so that as the heat rays pass through the air, to and from the surface of the snow, they have but little effect as regards raising the temperature of the air. Air such as this is said to be diathermanous, and heat rays passing through such territory, so to speak, pay no toll. Similarly snow, so long as it remains clean and free from impurities, reflects the heat rays, but will not absorb them. Supposing, however, that a little dirt or a plentiful supply of coal-dust settles on such snow, heat is at once absorbed, and the "frozen flowers" are destroyed. That the snow is white is considered to be due to the fact that the ice crystals of which each individual snowflake is built up, act as so many miniature prisms that blend the prismatic colors and so scatter a white light. In its embrace also each snowflake as it lies upon the ground, holds a tiny supply of air, and it is this circumstance that makes the snow so bad a conductor of heat. Snow then in regard to the earth and the atmosphere acts as a buffer state, so that it passes no heat down from above and allows none to travel upward from below.

Further, not only is snow of interest in the manner of its birth and in respect of its sojourn on the earth, but its actions are no less entertaining when it melts. In passing it may be observed that one foot of snow is considered to be equal to ten or twelve inches of rain. When, therefore, snow is on the ground to the depth of several feet there is an enormous quantity of moisture held in suspension. It is not surprising that when a sudden thaw sets in, the water courses and rivers are unable to carry off the melting snow, and that floods result. At times, too, it will happen that the ground in the neighborhood of fallen snow is frozen hard, so that as the snow melts it rushes impetuously onward, disastrous floods being again produced. When the snow disperses in orderly fashion it percolates through the ground, and it will readily be understood that as the cold icy water passes downward notable modifications occur in the temperature of the soil. At such times undrained land becomes saturated with the chilly water, and for this and other reasons it has been observed that the effect of draining land is the same as if it had been removed one hundred miles to the southward. It is not, therefore, surprising that in many countries considerable attention is given to the work of observing the snow, so that ample warning may be given to those whom it may concern of the time when it is beginning to melt.

Both when on the ground and when it melts it will therefore be seen that snow is constantly modifying the temperature of its surroundings. On the winds also which blow to and from the snow-covered areas these changes have also their effects, so that in studying climatic conditions it is imperative to know the times and seasons when a given locality is covered with snow. As already mentioned, to follow the biography of a snowflake to the end, something should be said concerning glaciers and icebergs; but it is sufficient for present purposes to call attention to them, with the observation that they were built by the snowflakes.—Knowledge.

WORLD'S COAL SUPPLY.

"THE World's Coal Supply and Trade" is the title of a monograph just issued by the Treasury Bureau of Statistics. It shows that the United States not only leads the world in coal production but has advanced from third place to the head of the list since 1880. In that year the United States produced one-fifth of the coal of the world; last year its production was one-third of the total of the world. The coal production of the United States has quadrupled since 1880, while that of the remainder of the world has not quite doubled. The three great coal-producing countries of the world are the United States, United Kingdom and Germany. These three countries produce practically 80 per cent of the world's coal. Since 1880 the United States has increased her output by 221,000,000 short tons, Germany by 103,000,000 tons, and the United Kingdom by 80,000,000. The relation of these three great coal-producing countries to the world's coal supply, and the growing importance of the United States in that relationship are indicated by the following table which shows the production in each of the three, and in all other countries, in 1880 and 1901, and the actual increase and per cent of increase in each case:

Countries.	Production in 1880. Short tons.	Production in 1901. Short tons.	Increase from 1880 to 1901. Short tons.	Per cent of increase.
United States.... .	71,481,569	293,298,516	221,816,947	310 6
United Kingdom. .	164 605,738	245,332,578	80,726,840	49 2
Germany..........	65,177,634	168,217,082	103,039,448	158.4
All other..........	63,472,464	155,317,364	91,844.900	144 8

It will be seen from the above figures that the United States not only advanced from third place to first in the period from 1880 to 1901, but that her actual increase in production was nearly as much as that of all the rest of the world combined, the actual increase from 1880 to 1901 being: United States, 221,816,947 short tons; all other countries, 275,611,188 tons.

The following table shows the coal production of the world in the latest available year, the figures for the United States, United Kingdom, Germany and France being for 1901, the others for 1900:

Countries.	Short tons.	Per cent of total.
United States	293,298,516	33.86
United Kingdom	245,332,578	28.32
Germany	168,217,082	19.42
Austria-Hungary	43 010,761	4.96
France	35,596,536	4.11
Belgium	25,856,024	3.00
Russia	17,799,016	2.00
Japan	8,187,262	1.00
Other countries	28,867,765	3.32
Total	866,165,540	100.00

While the United States is the world's largest producer it has as yet accomplished little as an exporter. The following table shows the exportation of coal in excess of imports, of all countries whose exports exceed the imports. The figures are in metric tons of 2,204 pounds and are for the latest available year, in most cases for 1901.

Countries.	Exports in excess of imports. Metric tons.
United Kingdom	57,775,000
Germany	11,103,000
United States	5,463,000
New South Wales	3,362,000
Belgium	3,264,000
Japan	2,809,000
Natal	302,000
India	239,000

The following table shows the total importation of coal in the principal countries of the world at the latest available year, in metric tons, and thus indicates the principal markets of the world:

Countries.	Imports of coal. Metric tons.
France	13,929,000
Germany	6,790,0 0
Austria-Hungary	6,440,000
Italy	4,829,000
Canada	4,343,000
Russia	3 631,000
Sweden	3,130,000
Belgium	3,102,000
Spain	2,153,000
Australasia	1,985,000
Argentina	929,000
Brazil	790,000
Mexico	760,000
Cuba	372,000

THE ATOMIC THEORY WITHOUT HYPOTHESIS.

As will be gathered from the title given to it by its author, the Presidential Address delivered to Section B of the British Association at Belfast by Prof. Divers, deals with an exceedingly abstruse and highly polemical branch of chemistry or chemico-physics. Of the ultimate composition of matter—whether many, at any rate, of the substances we are pleased to consider as elements are actually and inherently elemental; or whether they are all different manifestations of one and the same "Urstoff"—we know nothing; and opinions are still somewhat divided as to the penultimate composition thereof. The phrases "atomic theory" and "atomic hypothesis" are frequently employed as exact synonyms; but taking the precise significance assigned to them by Dr. Divers, the atomic hypothesis is the popular form of the idea. According to this, matter is discontinuous or coarse-grained; a certain substance is made up of an inconceivable number of identical molecules, each of which is, in its turn (usually) composed of two or more atoms. Each atom is so small as to be incapable of further sub-division; so small that it cannot exist alone; and each atom, if the substance is an element, in the molecule is identical, whereas different atoms (i. e., atoms of different elements) are present in the molecule of a compound. The hypothesis also assumes that each atom in the molecule is, in comparative language, widely separated from all its neighbors; so that the molecule, to use the well-known simile, is a microcosmic analogue of a bag of shot. Each atom, moreover, and consequently every molecule, possesses a specific relative weight, so that if the atom of hydrogen is taken as unity for convenience—it having been the lightest body known to chemists—the atom of sodium is 23 times, and that of chlorine 35 times as heavy. In other words, since atoms rarely exist alone, and since there are two atoms in the molecules of each of the substances mentioned, while the smallest quantity of hydrogen which can take part in a chemical reaction is two parts by weight, the smallest quantities of sodium and chlorine, similarly active, are 46 and 70 parts by weight respectively. There are difficulties in the way of this conception when carried out logically, and so we come to the atomic theory which, in Mr. Divers' words, is that "the quantities of substances which interact in single chemical changes are equal to one another, as truly equal in one way as equal masses are in another, and therefore that chemical interaction is a measure of quantity of unlike substances, distinct from, and independent of, dynamical or mass measurement." This leads to what is at first sight anomalous, viz., that chemically speaking, sodium chloride should be regarded as a compound of one part of sodium with one of chlorine, whereas physically, or from the mass point of view, it is a compound of 23 parts of sodium and 35 parts of chlorine. We are so accustomed, in scientific inquiry as in daily life, to measure mass by weight, that we are prone sometimes to forget that there are other ways of estimating it, while the learner of physics finds one of his first great difficulties in separating the two ideas. As this is so well-known a trouble to the student, perhaps we may be permitted a coarse illustration. When there is a contested vacancy in Parliament, the returning officer counts the number of people voting for each candidate; he does not ascertain their collective weights, nor their united heights, nor their brain power; he determines mass by number of particles, ignoring weight and size altogether. To the election agent one Conservative is exactly equivalent to one Liberal, just as to Dr. Divers one molecule of sodium is equal to one molecule of chlorine; while one man may be 9 stone and a genius, and the other 18 stone and a fool—totally different in weight and certain properties, as are the two molecules of sodium and chlorine in all respects save combining power.

Dr. Divers proceeds in his address to deal with radicles, which, in opposition to the powers that be, he prefers to spell "radicals," and then he treats of valency, elaborating his argument as clearly, perhaps, as the nature of the subject permits. It seems to follow that our old friend the atom is no longer the property of the chemist. If it is necessary for physical and mathematical reasons for the physicist to think in atoms, and even if, as so many authorities hold, atoms have an objective existence, the raw material of the chemist is the molecule. There is no such thing as chemical addition, only interaction. It is not correct to write the common equation $C + O = CO$; we must write $C_2 + O_2 = 2CO$. One atom of carbon does not adhere to one of carbon simply; the two atoms in the carbon molecule, and the two atoms in the oxygen molecule, each separate, and each take new partners, yielding two molecules of carbon monoxide, each of which contains one atom of carbon and one of oxygen. Much of Prof. Divers' address relates to the subtle difference between composition and constitution, which is the basis of organic chemistry. There are hosts of organic bodies—those known as isomers and polymers, etc.—which have an identical composition (i. e., percentage composition), but which differ in physical or chemical properties, or both. These are matters for the chemist mainly to study, and are somewhat beyond our purview; but we may instance the common substance, benzene, whose formula is C_6H_6, whereas that of acetylene, as different from the former as possible, is C_2H_2—numerically one and the same thing.

A LONG-NOSED MONKEY.

KNOWLEDGE says that the Zoological Society's menagerie has recently been enriched by the addition of a living example of the proboscis-monkey of Borneo, the first of its kind ever received in the gardens. Unfortunately the specimen, which is a male, is immature, so that it does not show the great development of the nose characteristic of the adults of that sex. Should it survive and grow to maturity, it will serve to correct the ordinary idea of the form of that appendage. For it is a singular coincidence that Dr. Jentink has just published a photograph of the monkey, taken from a living adult male, which shows that the nose, in place of being narrow and projecting straight forward, is spatulate and bent downward so as to conceal the mouth in a full face view.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Automobiles in Latin America.*—

ARGENTINA.

Consul J. M. Ayers, of Rosario, writes:

Tariff.—The duties on automobiles here are 25 per cent of the declared value.

Market Conditions.—There are at present in Rosario but two of these vehicles, one being from the United States (earlier model) and one from France.

The article is so expensive as yet that it is within the reach only of persons of large means, many of whom in this country do not readily adopt new inventions. A doubt of their safe manipulation will also retard their general introduction. Yet I should say that within the next year, it would be of great advantage to our manufacturers of these vehicles to have an active representative here in the person of a Spanish-speaking salesman, having some of the automobiles with him so as to show their working, and thereby call attention to their excellence. By such a course, American machines would have a good chance of sale to these people, who, when convinced of superiority, make liberal customers.

At the present time, it would not be advisable to make this effort, for this country is just passing through a year of crop failures which forbid indulgence in any extravagances or experiments. The outlook for the coming year is bright.

BRAZIL.

The following has been received from Consul-General Eugene Seeger, of Rio de Janeiro:

Tariff.—The automobile has not yet found its place on the tariff list of Brazil. When coming from foreign shores, it will have to enter incognito, under the general title of "machinas" and pay 50 per cent ad valorem.

Market Conditions.—I am not inclined to think that there is much of a future for the automobile within the limits of the Brazilian Republic. Climate and topography, as well as the conditions of the roads and streets and the individuality of the native population, militate against it.

On the country roads, the ox cart will easily hold its own during the present generation against such newfangled contrivances as the automobile, and in the cities the medieval condition of the streets and thoroughfares precludes the general use of any vehicle whose speed is apt to contrast with the conservatism of the tropical mule. In the Tropics, swift locomotion and the sense of comfort and pleasure are considered incompatible.

In my travels throughout Brazil, in the vast continent between the Amazon and the River Plata, I encountered but three automobiles—one in Para and two in Petropolis.

I know only one Brazilian city where the automobile could find proper conditions—Sao Paulo, which has a few good roads and streets, an agreeable climate, an industrial and progressive population, and a leisure class.

CHILE.

Consul R. E. Mansfield reports from Valparaiso:

There is no law upon the statute books of Chile relating to automobiles. This is probably due to the fact that there are no vehicles of this class in use in the country. There is no record of a single automobile having been imported into Chile, and inquiry reveals the fact that there is no demand for this vehicle, and that not one is to be found in the country.

The absence of this class of vehicles is perhaps due to the fact that there are few improved country roads in Chile. Much of the country is mountainous—some of it inaccessible. The streets in the cities and towns are paved with cobblestones, are very rough and uneven, and are not suited to automobiles.

Modern vehicles, such as coaches, carriages, traps, etc., are not manufactured in Chile. They are imported from the United States, France, and England, the largest number, according to statistics, coming from the United States. There is a duty of 60 per cent on all vehicles imported into Chile.

MEXICO.

Consul-General A. D. Barlow writes from Mexico City:

Tariff.—Customs duties on automobiles imported into Mexico are the same as on carriages intended to be drawn by horses, viz:

On first 100 kilogrammes (220.4 pounds), 60 cents (Mexican) per kilogramme, net weight; from 100 to 250 kilogrammes (220.4 to 551 pounds), 55 cents per kilogramme, net weight; from 250 to 500 kilogrammes (551 to 1,102 pounds), 50 cents per kilogramme, net weight; from 500 to 750 kilogrammes (1,102 to 1,653 pounds), 45 cents per kilogramme, net weight; from 750 to 1,000 kilogrammes (1,653 to 2,204 pounds), 40 cents per kilogramme, net weight; excess over 1,000 kilogrammes (2,204 pounds), 35 cents per kilogramme, net weight. To the above is to be added the 10½ per cent levied on all dutiable goods for port works, etc.

To illustrate: An automobile weighing 600 kilogrammes (1,322.6 pounds) would pay the following duties:

Description.	Duty. Mexican.	
First 100 kilogrammes (220.4 pounds), at 60 cents per kilogramme	$60.00	$25.50
Second 150 kilogrammes (330.7 pounds), at 55 cents per kilogramme	82.50	53.06
Third 250 kilogrammes (551.1 pounds), at 50 cents per kilogramme	125.00	53.13
Fourth 100 kilogrammes (220.4 pounds), at 45 cents per kilogramme	45.00	19.13
	$312.50	$132.82
Plus 10½ per cent	32.81	13.94
Total	$345.31	$147.76

Market Conditions.—There are in use in this city about 50 automobiles. Most of them are electric machines of American manufacture, the largest agency here (that of the Pope Manufacturing Company, of Hartford, Conn.) having sold most of them. There are two or three gasoline automobiles of French origin in use here, and several steam automobiles of American manufacture. The electric automobiles in use are of all styles and prices, some very handsome ones being owned by the wealthier people and ordinary ones by others. Some public omnibuses and wagonettes were run by a local company, but more as an advertisement than as a business venture, and they were discontinued in public service after a short time. The sale of automobiles, especially those of American manufacture, has been pushed as energetically here as the conditions would permit. Owing to the high rate of exchange, the duty, and freight, automobiles are very expensive. Only the wealthier classes are able to afford them.

The principal drawback to the use of automobiles in Mexico is a lack of good roads. There are no country roads in the Republic suitable for their use, and few in the cities. Except in three or four of the larger cities, as Mexico City, Guadalajara, Puebla, and Monterey, there can be no sale for automobiles until there are better roads. Even in this city, the streets and drives suitable for the use of automobiles are very limited, probably not exceeding a dozen miles in all. Outside of this city, there are not more than two or three automobiles in use in the whole republic, and at present there is no possibility of creating a market for them. A few more may be sold here, but probably not many until the good roads are extended.

* The reports in this issue of Advance Sheets are part of the series in answer to Department instruction of April 28, 1902, begun in Advance Sheets No. 1488.

International Exposition at Athens.—The International Exposition of Industry, Commerce, Art, and Hygiene,* which was to have been opened in Athens the 15th of October, has been postponed until the 7th of April, 1903, as recently announced through the Foreign Ministry. This postponement has been found necessary in order to allow the Greek Government more time for the organization of the movement. Incidentally, it will allow more time for foreign nations to participate. Our export interests could not have made a creditable showing at the first-named date. Now that six months' additional time is to be given, an intelligent display of American products is made possible. It would be difficult to say along what lines special effort should be made, since the Greek market is open to almost everything in the way of manufactures. Certainly, farming implements, mechanical instruments, and devices of every sort, including typewriters, letter and printing presses (particularly hand and foot power presses), engines of various types, currant-cleaning machinery, lighting apparatus, lamps, dynamos, and electrical appliances, and a long list of similar goods will find favor with the Greek people. It is probable that many of the articles displayed could be disposed of in this market, and such as could not be sold at once could be continued on exhibition at a nominal price by what is to be known as the American Importers' Association, which will undertake, when formed, the display and sale of American goods of all kinds.

An American exhibit may induce a like favor for the Louisiana Purchase Exposition.

Direct boats are now running between New York and Piræus, which will insure good transportation rates and quick and safe service.—Frank W. Jackson, Consul at Patras.

The Markets of Hungary.—A writer in the official commercial paper of this Kingdom points out the necessity of Hungary focusing and centralizing her markets as West European countries do. While the exporting stations are numerous, Vienna is still the market for many Hungarian products, Budapest has in its time been the market for Servian prunes, but the Servians have done everything to establish a direct export and to dispense with the Budapest market. Hungary has done something in establishing produce associations for milk, butter, eggs, fruit, vegetables, etc.; but at present there are only exporting stations, no great markets, in the country. American importers buy Hungarian beans in Vienna, Trieste, Prague and Marseilles. It is desired here that Budapest shall have suburban markets, and that there should be special markets for particular products throughout the Kingdom. Makó, it is claimed, can supply onions; Szeged, red pepper and farina; Liptószentmiklós and Rózsahegy, sheep-milk curds; Vagujhely, gin; Ilok-in-Croatia, plum brandy; Budapest, salami, butter, champagne and mineral waters; Debreczen, sausages, etc.

The reason that Hungary has no important markets is believed to be that social, or, as Americans term it, private enterprise, is still weak, and not only the initiative, but the permanent action in each case is expected from the State or local authorities. The pork market of Kóbanya (east side of Budapest) did come into existence through private action, but the beef market of Budapest required both State and city help to assure its beginning and maintenance. The wool markets of Losconcz and Miskolcz were privately created, but that of Budapest depended upon the favorable action of the government.

The number of export stations in Hungary is very large, but they are known only to the Jewish commission houses in Budapest, who register at the court of commerce as commission merchants to save in taxes, but represent themselves to the outside world as exporters. As a matter of fact, they usually buy from the country producers only upon receipt of advance orders sufficient to protect them.—Frank Dyer Chester, Consul at Budapest.

American Coal and French Gypsum.—One of the prominent Rouen shipping and forwarding firms informs me that it would be glad to learn if there is any demand in America for the finest grade of gypsum known, delivered f. o. b. Rouen at 8 francs ($1.544), or f. o. b. Havre at 11 francs ($2.123) per ton.

One of the greatest hindrances to the introduction of American coal into northern France is the want of a return cargo. If there is any demand for gypsum at the low prices mentioned, it might be advantageous for parties interested to communicate with this firm, which owns extensive gypsum deposits between this port and Paris, and with its own vessels, engines, cranes, etc., possesses unequaled facilities for taking in hand, discharging, reshipping, and carrying foreign coal or any other importation from Havre or Rouen to Paris or other destinations.

* See Advance Sheets Nos. 1407 and 1463; Consular Reports, No. 264.

I am told that the Paris gas company, the largest in the world, uses annually 1,200,000 tons of coal, of which 200,000 tons have been coming from England—80,000 by way of Rouen. In face of the unceasing miners' disturbances in France, which at present are more threatening than ever, a greater quantity must necessarily come from abroad.

The address of the firm mentioned above is Fretigny Fils, 13 rue Centrale, Rouen; or communications to this consulate will be promptly delivered.—Thornwell Haynes, Consul at Rouen.

Automobiles in Cape Colony.—Consul-General W. R. Bigham reports from Cape Town:

Automobiles here are called motor cars; and, although this business is practically in its infancy, there are a few horseless vehicles to be seen on the streets of this city, and I am told the same is true of other cities on the coast. Owing to the unsettled condition of this country on account of the war, but few have reached the interior.

The military have used some American steam-motor cars (the Toledo car taking the lead in number) and they have given great satisfaction.

Difficulty is experienced in getting orders filled properly and in having the goods delivered at the ports of this far-away country. It is claimed that both American and European manufacturers have been unable to fill orders promptly, aside from taking care of their home trade, and do not seem to wish to make much of an effort to get trade so far away.

Fuel.—Gasoline is almost unknown away from coast cities, and it can only be procured in three places in this city. All steamships reserve the right to throw it overboard if they encounter a storm; for, if one of the cans or other vessels in which it is shipped should be broken by the pitching of the ship and the air permeated with the gas, it would result in an explosion by coming in contact with the fire under the boilers or the lights at night.

Many shipments have gone into the sea from this cause, thus preventing the merchants in this and other countries from receiving their expected stock. This makes it very expensive and uncertain of supply. Kerosene (called paraffin here) would be much better for creating motive power than gasoline, for it can be purchased of any grocer throughout this country at about one-half the price. Kerosene retails here, by the case containing two 4-gallon cans, at 35 cents per gallon.

Styles.—A few motor bicycles are in use here, mostly of American manufacture. With regard to motor cars, I am told that the strongly built high-horse power vehicles are the most successful. On South African roads, high horse power is required in ascending the long, steep hills. Medium or low priced vehicles sell best. The harbor authorities in this city have a motor dray wagon in use.

As there is very little food for horses grown within 500 miles of this city and railroad freight is very high, it is found cheaper to ship grain and hay from the Argentine Republic, Australia, or the United States than to get it from the interior, and this increases the expense of keeping horses. A liveryman boards a carriage horse for $1.82 per day, and as they are fed entirely on imported feed, that is considered a fair price. I think any motive power that will take the place of a horse should succeed here.

Tariff.—There is no duty on the machinery of an automobile, but the vehicle part is appraised at about what the value of a carriage of the same capacity would be, and an ad valorem duty of 25 per cent is collected on this valuation.

Laws.—There is no license required for automobiles used here, except if used for hire or to transport passengers (as cabs or landaus about the city).

I can find no other laws which apply to automobiles in this colony. It is possible that some cities have enacted ordinances on this subject, but I do not know of any. All vehicles here are obliged to carry side lights after nightfall.

I am largely indebted for my information to Mr. H. L. Jenkins, an enterprising American, who is now in the United States buying a stock of automobiles. His firm has introduced nearly all of these goods that have been landed in Cape Town.

French Demand for Superphosphates.—Consul G. H. Jackson, of La Rochelle, under date of September 2, 1902, reports a demand for American superphosphates (fertilizers). Three thousand tons have been recently sold, and there is an immediate opening for 15,000 tons to one party. Letters should be addressed to the consulate, giving prices f. o. b. Tampa, Fla., and c. i. f. La Rochelle, delivered on cars alongside.

Inquiry for American Advertising Novelties.—Consul Marshal Halstead, of Birmingham, under date of September 27, 1902, says:

I have an inquiry for the names and addresses of manufacturers of advertising novelties, foot rules, etc., of the kind given away by business establishments to customers and possible buyers as a memorandum of address and business.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Rose Maréchal Niel.—In the genus of roses, outside of the hundred-leaved or cabbage rose, the Maréchal Niel rose (Rosa Noisetteana Red), also called Noisette rose and often, erroneously, tea rose, is especially conspicuous. Its fine, piquant odor delights all lovers of precious perfumes. In order to reproduce the fine scent of this flower artificially at periods when it cannot be had without much expenditure, the following receipts will be found useful:

Extrait d'Odeur à la Rose Maréchal Niel.

Infusion Rose I. (from pomades)	1,000	grammes
Genuine rose oil	10	grammes
Infusion tolu balsam	150	grammes
Infusion genuine musk I	40	grammes
Neroli oil	30	grammes
Clove oil	2	grammes
Infusion tubereuse I. (from pomades)	1,000	grammes
Vanillin	1	gramme
Coumarin	0.5	gramme

This recipe yields a magnificent perfume and is very popular.

The soap belonging to this assortment is produced as follows:

Savon à la Rose Maréchal Niel.

White stock soap A1	50	kilos.
Wax yellow (Hessel & Co.)	10	kilos.
Artificial rose oil	35	kilos.
Geranium oil	50	kilos.
Neroli oil	20	kilos.
Cananga oil	10	kilos.
Vanillin	5	kilos.
Coumarin	1	kilo.

To the set is added a

Poudre à la Rose Maréchal Niel.

Rice flour	5,000	grammes
Talcum, 0000	5,000	grammes
Carbonate of magnesia	5,000	grammes
Potato flour	5,000	grammes
Artificial rose oil	10	grammes
Geranium oil	30	grammes
Neroli oil	3	grammes
Vanillin	1	gramme
Infusion tolu balsam	50	grammes

A sachet powder for sachet bags for the same set is prepared as follows:

Poudre de Sachet à la Rose Maréchal Niel.

Powdered rose leaves	1,000	grammes
Powdered orris root	3,000	grammes
Artificial rose oil	10	grammes
Residues of musk	50	grammes
Artificial musk	1	gramme
Vanillin	5	grammes
Coumarin	1	gramme
Infusion tolu balsam	100	grammes
Neroli oil	5	grammes
Geranium oil	20	grammes

All the aforementioned articles should be given a delicate, tasteful appearance by pretty labels and a modern make-up. Naturally, pictures of Maréchal Niel roses should be utilized to contribute to the handsome effect, making the whole a choice article. Regular sets in little boxes, made up of soap, perfume, powder and a sachet bag will doubtless meet with a ready sale for the Christmas season.—From the German of H. Anthony in the Seifensieder Zeitung.

To Produce a Flash-Light of Intense Brilliancy.—For photographing the interior of very large caves in such a manner as to bring out every possible detail the following, which originally appeared in La Nature, we believe, is recommended:

Magnesium in powder	20	parts
Barium nitrate	30	parts
Flower of sulphur	4	parts
Beef suet	7	parts

Melt the suet and add the other ingredients after having first mixed them by passing through a fine sieve. When thoroughly stirred in pour the mass into zinc boxes of a suitable size. A box 3 inches in diameter and 4 inches deep will hold about one pound and will give a flash of 20,000 candle power. Such a flash used in signaling in France has been seen at a distance of 100 kilometers, or about 62 miles.

How to Take Castor Oil.—The disgust for castor oil is due to the odor not to the taste, says F. S. Hough in the Iowa Medical Journal. If the patient grips the nostrils firmly before pouring out the dose, drinks the same complacently, and then thoroughly cleanses the mouth, lips, larynx, etc., with water, removing the last vestige of the oil before removing the fingers, he will not get the least taste from the oil, which is bland and tasteless. It all depends upon keeping any air from entering the nose during the time while there is any oil present.—Drug. Cir. and Chem. Gaz.

Bronzing for Brass.—The Deutsche Metallarbeiter gives the following: The articles, which must be free from grease and polished, are first immersed, for one-half minute, in a cold solution of 10 gm. of potassium permanganate, 50 gm. of sulphate of iron (ferrous) and 5 gm. of hydrochloric acid in 1 liter of water. They are then washed off and dried in fine soft sawdust. If the color has become too dark, or if a more reddish brown color is required, the objects are immersed, immediately after they have been taken out of the first bath, for about one minute into a warm (60 deg. C. = 140 deg. F.) solution of 10 gm. chromic acid, 10 gm. chloric acid, 10 gm. potassium permanganate and 50 gm. sulphate of iron in 1 liter of water, and treated as above. By using the second liquid alone, a brighter, dark-yellow, or red-brown color is produced. The objects may afterward be heated in a drying oven, whereby the color is considerably improved.

To Keep Machinery from Rusting.—In order to keep machinery from rusting take 1 ounce of camphor, dissolve it in 1 pound of melted lard; take off the scum, and mix as much fine black lead as will give it iron color. Clean the machinery and smear it with this mixture. After twenty-four hours, rub clean with soft linen cloth. It will keep clean for months under ordinary circumstances.—National Druggist.

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